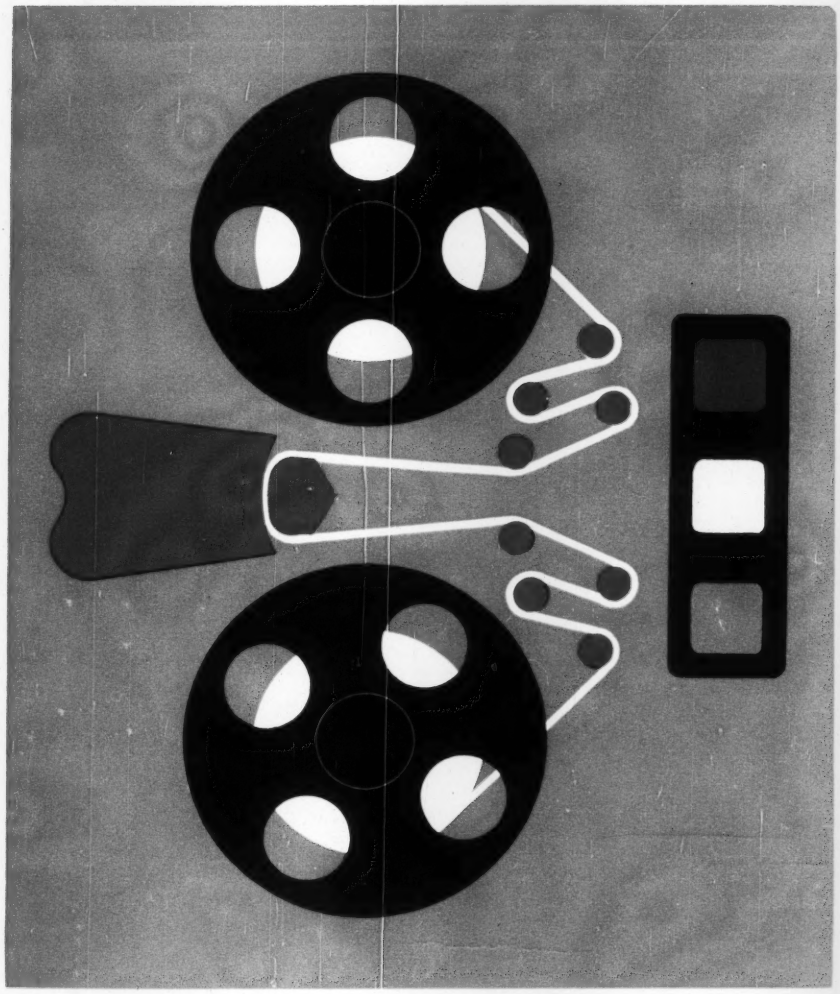
INSTRUMENTS AND CONTROL SYSTEMS

INCLUDING: INSTRUMENT MANUFACTURING • JOURNAL OF THE SCMA • SIMULATION COUNCIL NEWSLETTER



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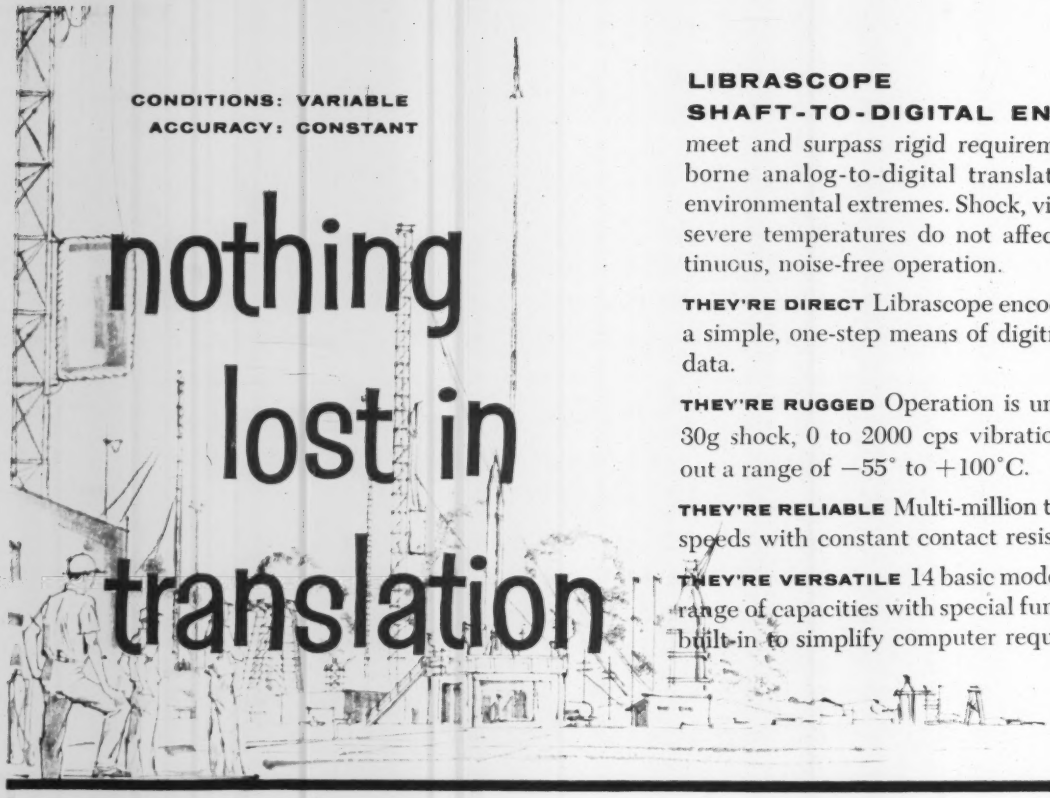

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THEY'RE RELIABLE Multi-million turns at high speeds with constant contact resistance.

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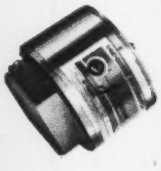
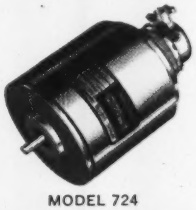
MODEL 740

MODEL 713



MODEL 758



MODEL 724

MODEL 708

OUTPUT CODE	MODEL NO. @	TOTAL CAPACITY	RESOLUTION PER TURN	DIMENSIONS DIA. x LENGTH
PARALLEL BINARY (LINEAR)	740	10 bits (1024)	1024	4 3/16" x 2 1/4"
	743	13 bits (8192)	128	2" x 3 15/32"
SERIAL BINARY (LINEAR)	707	7 bits (128)	128	2" x 2 45/64"
	713	13 bits (8192)	128	2" x 3 15/32"
	717	17 bits (131,072)	128	2" x 4 13/16"
	719	19 bits (524,288)	128	2" x 4 13/16"
SERIAL BINARY (SIN-COS)	757†	7 bits per quadrant* (4 quadrants)	512	2 1/4" x 4 1/16"
	758†	8 bits per quadrant* (4 quadrants)	1024	4 1/16" x 3 3/16"
BINARY CODED DECIMAL (8-4-2-1)	723	2,000	200	3 1/16" x 4 27/32"
	724	20,000	200	3 1/16" x 4 27/32"
	733	3,600	200	3 1/16" x 4 27/32"
	734	36,000	200	3 1/16" x 6 3/8"
	735	360,000	200	3 1/16" x 6 3/8"
GRAY	708	8 bits (256)	256	3 1/16" x 1 15/16"

@All models available with internally mounted isolation diodes for sequential multiplexing applications.

†Available in hermetically sealed servo-driven package as Models 757-S and 758-S.

*Including limit 1 and polarity information. Sine and cosine functions generated simultaneously and independently. One turn of shaft generates 4 quadrants of information.

For full details on Librascope shaft-to-digital encoders write for catalog E 11-1.

0001
0010
0011
0100
0101
0110

L19-1

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The Model 62 RT4F Resistance Thermometer is a sturdy, easy to read instrument with a six inch hand drawn scale. It is suitable for use in moving vehicles, is excellent for flight testing or for permanent panel installations. Operated by an ordinary dry cell and calibrated to standard "AN" bulb curves, this instrument is ideal for use with any of the resistance bulbs illustrated below. Other ranges available in °C or °F.

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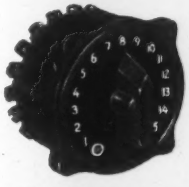
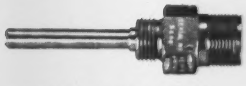
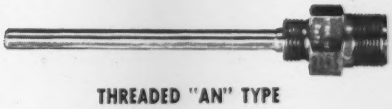


3" SIZE TO 20 POINTS

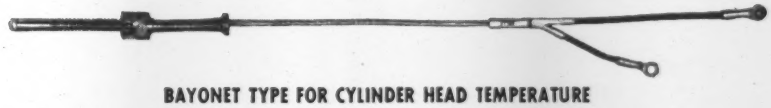


THREADED "AN" TYPE



THREADED "AN" TYPE

4" SIZE TO 28 POINTS



BAYONET TYPE FOR CYLINDER HEAD TEMPERATURE

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Manufacturers of *Complete* Temperature Measuring Systems for Aircraft

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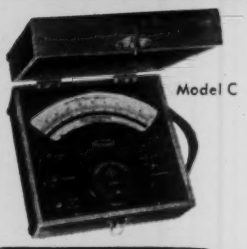
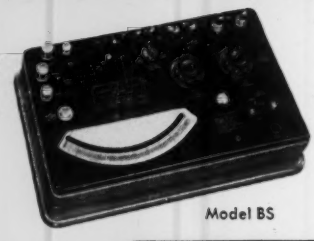
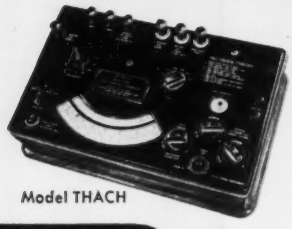

Model C

POLYRANGERS

Multirange DC Reference Standard .25% accurate current and voltage measuring instrument. 14 ranges from 1.5 ma. and 3V. to 3 amps. and 750 V. 6.3" scale length. Other Polyrangers with as many as 88 ranges self-contained available for AC or AC-DC use.


Model BS


Model THACH

LABORATORY STANDARDS

***"Self Checking"* DC Volt-Amp-Milliammeter. .05% accurate. 12" vernier scale. 25 full scale ranges from 1.5 ma. and .3 V. to 15 amps. and 1500 V. Internal standard cell. Other DC laboratory standards available with an accuracy of .1% and full scale ranges starting from 30 microamps or 50 mv.**

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Model INCRE

INCREMETER

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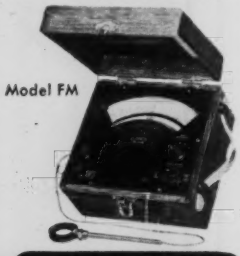
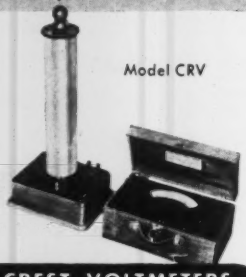

Model FM

FLUXMETERS

Single or multirange. Basic sensitivity 10,000 maxwells per division using a single turn search coil. Accuracy .5%. 5.2" scale length. Available with general purpose 10 turn search coil with a mean area of 8 square centimeters.


Model CRV

CREST VOLTMETERS

Measures RMS, positive and negative peaks of 10 per second or faster. Basic instrument is electrostatic voltmeter with accuracy of 1%. Ranges up to 100 KV. full scale. Input impedance 10,000 megohms. For AC or repetitive pulsed DC.

Model SCAMA

SCALE MACHINE

For the accurate drawing or redrawing of any laboratory standard electrical indicating instrument's scale whose arc is no greater than 110 degrees. Adapter to 270 degrees available for circular-scale instruments.

Model RFV

VOLTMETERS

True RMS responding. Full scale ranges from 1 V. to 300 V. Accuracy .5% on DC to 1 megacycle. Usable up to 10 megacycles. Other thermocouple instruments available for all current and voltage measurements.

Model UTS

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Replaces over 200 individual DC current, voltage and resistance measuring instruments. Accuracy .5%. Contains 3 instruments that may either be a millivoltmeter, voltmeter, milliammeter, or ammeter, and 1 microammeter. Portable. Other test sets available for AC and magnetic testing.

Model UPP

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Formerly INSTRUMENTS and AUTOMATION

MARCH 1959

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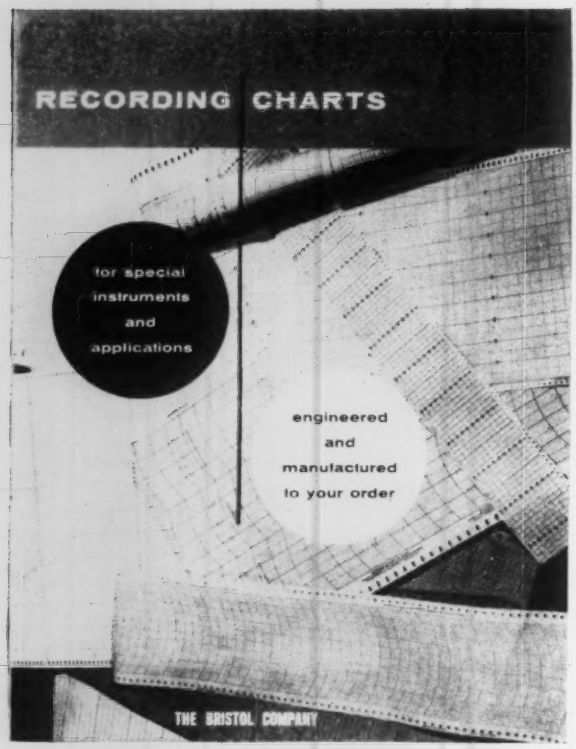
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INSTRUMENTS AND CONTROL SYSTEMS

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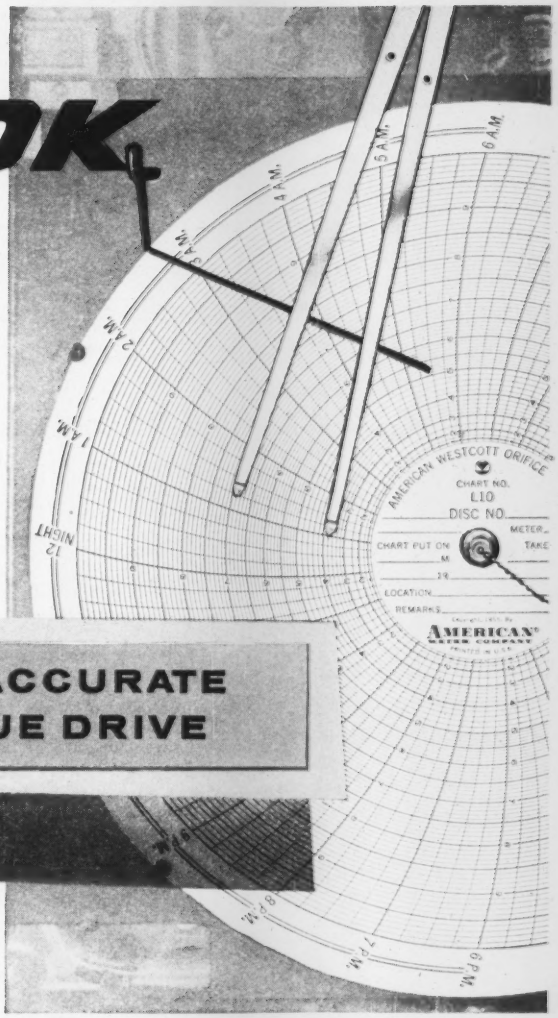

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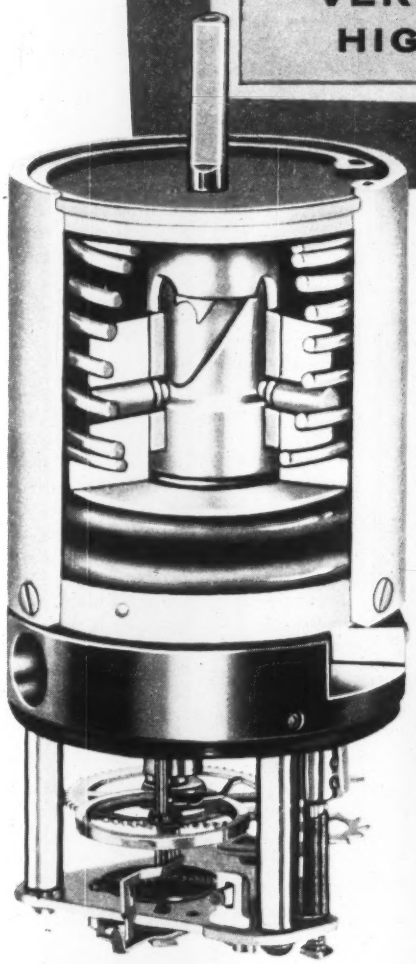

- Flexibility...ideal as original or replacement equipment for strip chart and conventional circular chart instruments.
- Built-in durability...timing mechanism internally sealed to prevent corrosion...large area internal ports prevent clogging.
- Rugged dependability...all power unit parts exposed to gas are aluminum or stainless steel...inherently explosion proof.
- Economical...normal air or gas consumption 5 cfh...operating pressure 5 psi...rotation 2 rpm.

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For saturating Alnico magnets weighing up to 34 lbs. and high flux ceramic magnets of any shape or pole configuration. Operates on condenser discharge principle from regular 115-volt, 60-cycle line.

Charging outputs from 100,000 to 200,000 ampere-turns through plug-in transformers, up to 3600 watt-seconds using wire-wound fixtures. Adapters for multi-pole rotors, rod, bar, ring and various other shapes available. Designed for continuous production use with low power consumption. Price of basic unit is less than $2100.

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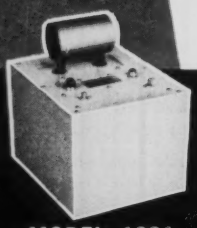

MODEL 1221

A low cost, condenser discharge unit employing novel, plug-in wire-wound type charging fixtures, the Model 1221 is designed for the user of small magnets. Its 10,000 ampere-turn output will saturate about 2" of Alnico V. Charging cycle rate is approximately 3 seconds, continuous duty, operates from 115-volt line. Price $180.

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Boonton, New Jersey, U. S. A.

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to the editor

Editor, I&CS:

Your article in the January 1959 issue entitled "Precision Potentiometers—A study of the Most Precise EMF-Measuring Device Available for DC Measurements" is most unfair to us.

No place in this article is the world's greatest manufacturer of potentiometers mentioned—Otto Wolff of Berlin. Wolff equipment helped to found NBS—he predates it by 12 years—and Wolff equipment is still in use in every country of the world where precise measurements are made.

(Dr.) James B. Kelley,
Physics Research Laboratories Inc.
Hempstead, New York

Pictures of actual commercial equipments were used in the article only to show the implementation of principles; not all manufacturers could be shown. We are pleased to acknowledge the historic and continuing contribution of Otto Wolff equipments (represented in the USA by Physics Research Laboratories Inc.) to precision electrical measurements. Several articles on bridges and other electrical instruments, showing Otto Wolff equipments, are now in preparation for our readers.

Editor I&CS:

As a subscriber to *Instruments and Automation* for several years, I have found your magazine very worthwhile and interesting. But in one specific area I have felt that sufficient coverage was not provided.

Within the testing laboratory, of which I am the chief, we have one group with the responsibility of repair and calibration of electronic test equipment. Instrument technicians are hard to find in this locality, therefore, by necessity, they must be trained on-the-job. Here the problem becomes one of providing readable material on the "care and feeding" of instruments.

I was pleasantly surprised to note the most excellent articles in the January 1959 issue. Might I request that you mail about five (5) copies of this January issue to me?

John M. Thompson
Rome Air Development Center
Rome, New York

Editor I&CS:

Your January issue contains articles on Electrical Indicating Instruments that will undoubtedly alleviate numerous problems encountered by meter manufacturers all over the country.

Thanks for bringing to light some of the things we have been trying to explain to customers for years.

Emerson Kirk
Phaostron Instrument & Electronic Co.
South Pasadena, Calif.

Editor I&CS:

(Referring to) your article INDUSTRIAL USES OF ANALOG COMPUTERS in *Instruments and Automation*, April, 1955.

May I obtain your permission to reprint this article for my students in Industrial Engineering? Also, I would like to obtain permission to quote from this in a publication that I expect to make.

James H. Greene, Ph.D
Purdue University
Lafayette, Ind.

Of course. Refer also to: (1) January, 1958 issue devoted entirely to systems and computers, including use of analog computers in process control. (2) February, 1958 issue, article on "Computer Designed Rolling Mill." (3) April, 1958 issue, "Simulation of a Solvent Recovery Process." (4) May, 1958 issue, "New Techniques in Analog Computation." (5) June, 1958 issue on "Simulation," (6) August, 1958 issue on "Distillation Column Dynamic Characteristics." (7) Refer also to the *Simulation Council Newsletter* in each monthly issue of *Instruments & Control Systems*, plus *The Computer Handbook*.

Editor I&CS:

You did a very fine job on a very difficult subject in your January issue. I appreciate the editorial space given to those articles contributed by Sensitive Research. On the other hand, I also enjoyed the articles written by some of our competitors, and thought them very worth-while. I believe this is the first time I have seen an issue in any magazine devoted entirely to such an important subject as electrical indicating instruments.

Marvin I. Steinberg
Sensitive Research Instrument Corp.
New Rochelle, New York

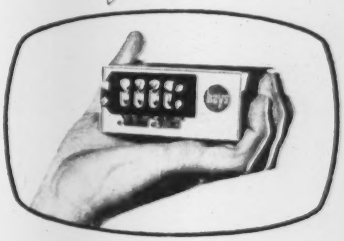
The response to the January issue is so great that other special issues on the same subject are planned. Hold on to your copies—no more are available despite an extra large print order.

RAMBLINGS ON INSTRUMENTATION

For those of you who missed our commercial on the EARLY, EARLY SHOW (4:00 a.m. EST) last February 29th, we herewith reprint a few excerpts from the videotape. The musical background (provided by a glockenspiel and cash register) must, of course, be imagined.

Phil Sprague Jr. President

ANNCR.: Oh, hello there. Say, friends, if you've been nervous, irritable, out of sorts lately...it may be due to nagging dry cells in your DC Voltage Supply. Well, now you can say good-bye to calomel calibrations for keeps with the amazing new...

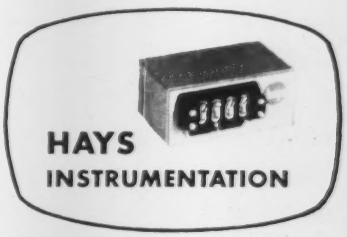


...HDCCVS! (Hdccvs is short for Hays DC Constant Voltage Supply, friends.) And here it is--the thinking man's DC voltage supply. Just plug it in to any 115-volt AC outlet enjoy cool, clean, accurate DC voltage...volt after volt after volt.

You can use the new Hays DC Constant Voltage Supply unit with practically any potentiometer type instrument...and put those dry cells back in your mother-in-law's hearing aid.

Imagine!--no more stabbing shoulder pains from lugging suitcase loads of batteries to the Bureau of Standards! No more calomel cells to pamper and polish!

Now, for you eggheads, the stability of this money-saving little rascal is ±.05% for ±20% supply voltage variations; ±.08% maximum drift over 10,000 hours of operation (readjustable); and ±.0045% max./°C. change in ambient temperature. Is that clear?



The Hays folks will be glad to bombard you with all the facts. Just drop them a postcard with your name and address. And tell 'em where you heard about it, friends. Now, back to our movie to see how Dustin Farnum is making out against those redskins...

THE HAYS CORPORATION • MICHIGAN CITY 8, INDIANA

For more information circle 7 on inquiry card.

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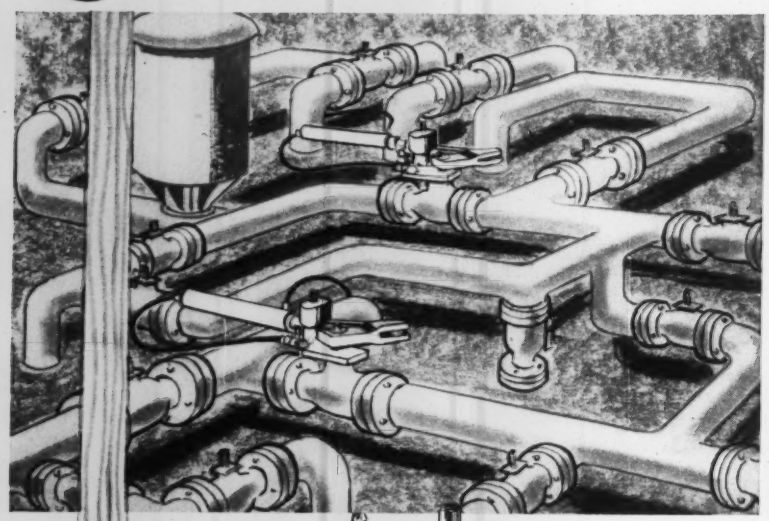
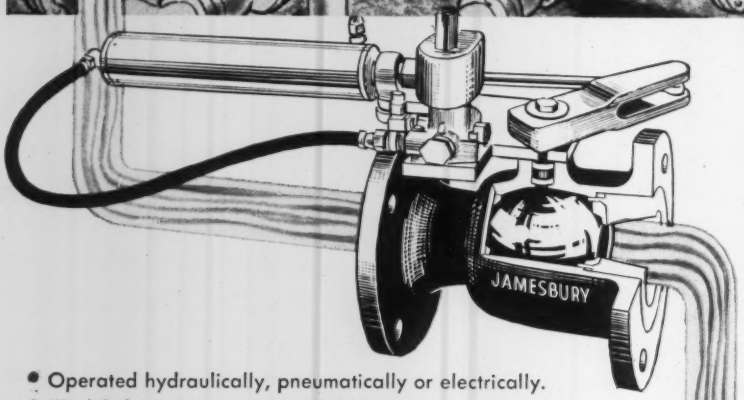
with **Jamesbury**

REMOTE OPERATORS*

for "Double-Seal"™ Ball Valves





- Operated hydraulically, pneumatically or electrically.
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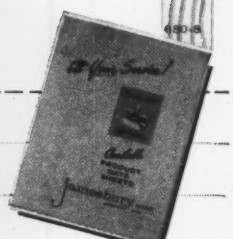

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LETTERS—CONTINUED

Editor, I&CS:

Your article on page 106 of INSTRUMENTS AND AUTOMATION, January 1959, dealt with the announcement of the new International Yard and Pound.

I have not been able to confirm the value 0.453592338 kg for the British pound, although I have found 0.45359243 kg in two other reference books. Would appreciate it if you would verify the value you gave in this article.

J. R. Connell,
Imperial Oil Limited
Sarnia, Ontario,
Canada

Mr. L. B. Macurdy, Chief, Mass Unit, Mass & Scale Section, National Bureau of Standards replies as follows:

"The value quoted for the British pound, 0.453592338 kg, as determined in 1933, is given in the Report by the Board of Trade on the Comparisons of the Parliamentary Copies of the Imperial Standards with the Imperial Standard Yard and the Imperial Standard pound and with each other, 1936."

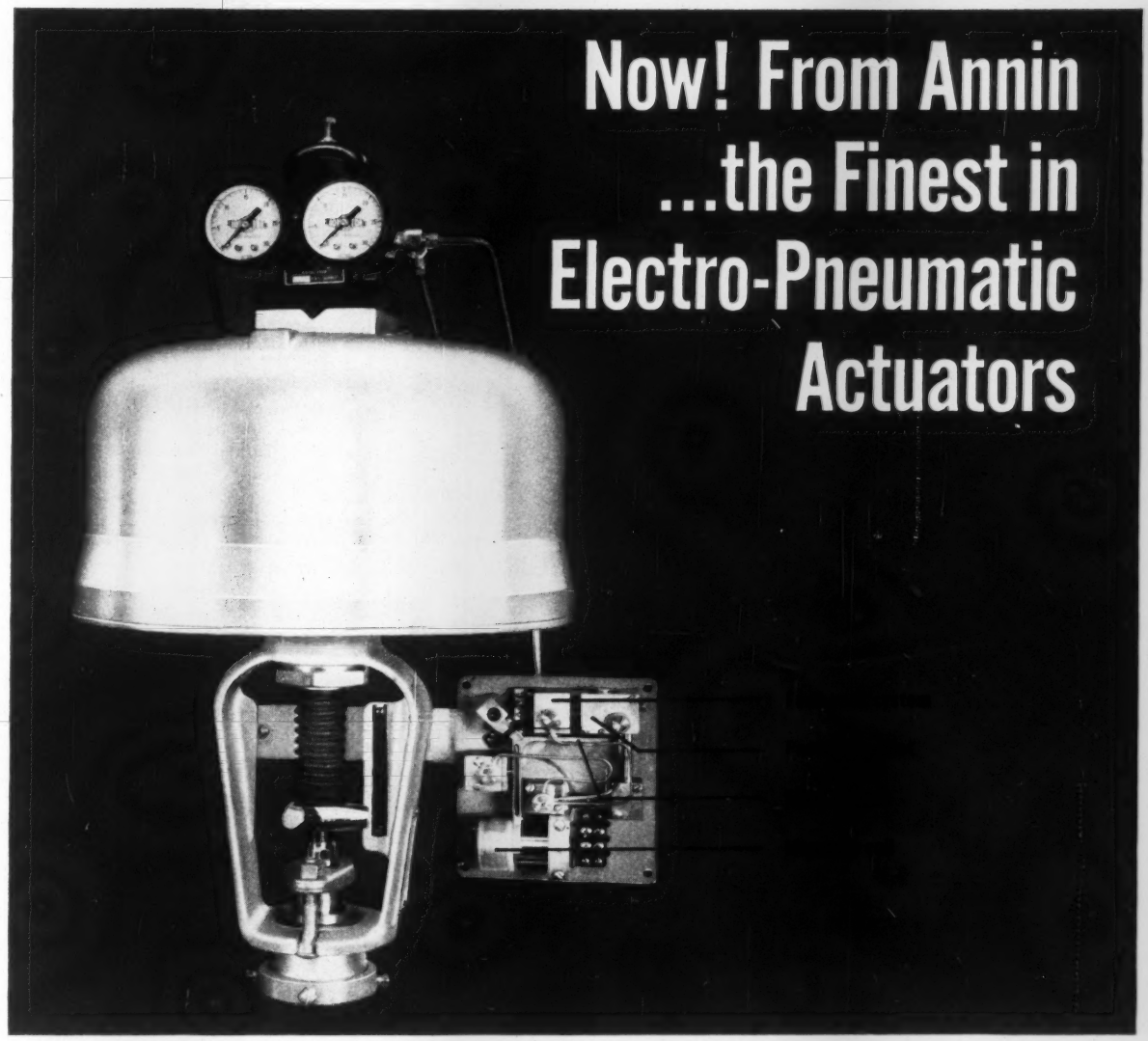
Editor, I&CS:

We have read with great interest the Editorial in your December 1958 issue, particulary with respect to the study projects in System Engineering.

For some time we have given considerable thought to the possibility of increased automatic process control in the Alumina Section (Bayer process) of our industry, and have discussed its possibilities with some of the engineers concerned. The reaction generally has been one of doubt as to the economic justification of automatic process control, due to the great number of process variables involved. Nevertheless we feel that quite a considerable amount of automatic control could be applied with satisfactory economic results.

We would be most interested to learn of any study projects concerned with the Bayer process in the Alumina industry. Even if investigations concerning this particular process have not been extended to computer control, we should be glad to know whether automatic process control, other than simple on/off control, has been applied in this field to any extent.

K. R. Hair
Australian Aluminum Production Commission
Bell Bay, Tasmania



Now! From Annin ...the Finest in Electro-Pneumatic Actuators

Annin's Model 30,000 transducer, coupled with the Annin Domotor, gives you greater range of adjustment, unequalled stability, and exceptional dynamic characteristics

The Model 30,000 has been developed to provide process engineers with a practical transducing element for converting a small electrical signal to an accurate and stable pneumatic output pressure. It embodies only four basic sub-assemblies, which minimize motion and wear, simplify adjustment and installation. The Model 30,000 features full-scale zero adjustment and a wide range of span settings for split range and sequencing applications. Absence of complex components, together with minimum installation,contribute to low maintenance. Linearity and accuracy reach a new high in electro-pneumatic transducing with the Model 30,000. *Technical data on request*

Annin VALVES

Send for your copy of Annin's new Catalog 1500-D

Annin VALVES

THE ANNIN COMPANY Division of The Annin Corporation
1040 S. Vail Ave., Montebello, California

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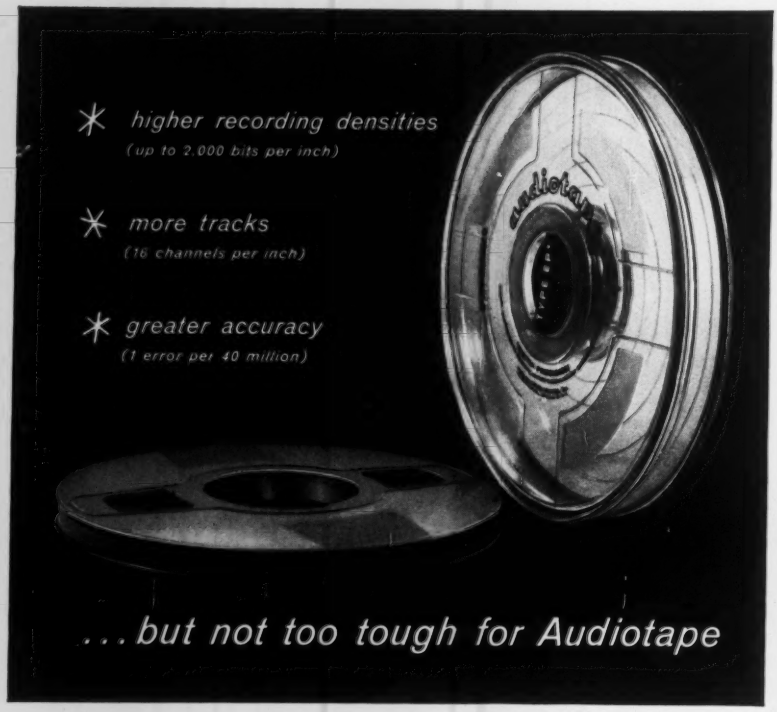
Tape specs are getting tougher every year


* higher recording densities
(up to 2,000 bits per inch)
* more tracks
(16 channels per inch)
* greater accuracy
(1 error per 40 million)
audiotape
...but not too tough for Audiotape

Keeping *ahead* of its customers is the only way a magnetic tape manufacturer can meet the rapidly rising standards being set for its product. And often the standards are as varied as they are exacting. Special slitting tolerances, coating thicknesses, base materials and magnetic oxides are rapidly becoming more usual than novel. Audio Devices' battery of Automatic Certifiers is one of the unique means used to make sure EP Audiotape always meets customer specifications.

Type EP Audiotape is the *extra precision* magnetic recording tape for applications in computing, automation, telemetering and seismography. The Automatic Certifier records and plays back every inch of the EP Audiotape under test. These tests can be so demanding that if the tape fails to reproduce a single test pulse out of the 40 million put on a single reel, the entire reel is rejected. There are no ifs, ands or buts.

This is one of many special quality-control operations to which EP Audiotape is subjected. From raw materials to hermetically sealed containers, every reel gets individual attention.

EP Audiotape quality is so well verified by instruments like the Automatic Certifier that every reel is guaranteed to be defect-free! For more information write for free Bulletin T112A. Write Dept. TI, Audio Devices, Inc., 444 Madison Avenue, New York 22, N. Y.

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AUDIO DEVICES, INC.
444 Madison Ave., N. Y. 22, N. Y.
In Hollywood: 840 N. Fairfax Ave.
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Export Dept.: 13 East 40th St., N. Y., 16
Rectifier Division: 620 E. Dyer Rd., Santa Ana, Calif.

For more information circle **10** on inquiry card.

LETTERS—CONTINUED

Editor I&CS:

Due to my immediate departure for Japan, for 1½ to 2 years, kindly change my address on the *Instruments & Control Systems* subscription list.

That far away from home, I cannot think of any publication which I will need more for complete reference purposes than your magazine.

Werner D. Jung
Catalytic Construction Company
Philadelphia, Pa.

Editor I&CS:

I notice your Reader Inquiry A 370 about air bearings. Some work in this field has been done at Reading University, England, under the aegis of the National Research Development Corporation. I would be glad to supply further details.

Philip Wright
National Research Development Corp. of London, England
(Washington, D. C.)

reader inquiries

Metal Detector

Consulting engineer in Holland is seeking a metal detector which can locate steel nails in 5" to 10"-dia wooden logs. A-379

X_1-X_2-Y Recorder

Engineer with computer manufacturer wishes to obtain information on X_1-X_2-Y recorders and on making engineering drawings with X-Y recorders. A-380

Temperature Instrument Repair

Importer of pyrometers, thermistor temperature indicators, etc., seeks repair service for his instruments. A-381

Alumina Process Control

Australian government agency would like to obtain information on automatic control (other than on-off) for alumina (Bayer process). A-382

Ratio Relay Valve

Project engineer of contracting firm seeks 16 non-leak-type ratio relay valves to operate diaphragm control valves (at dead end), to these specs: Input: 3 to 15 psig; output 20 to 260 psig, varying at 20:1-ratio from 20 to 260 psig; supply pressure 280 psig; volumetric displacements: 10 to 100 cu in (depending on operator size); response time: 90% of output signal in 10 sec; adjustable input/output ratio of 16:1 to 24:1 desirable; offset adjustment between input and output desirable; expected cost: under $100/piece for a fixed-ratio type. A-383

Smoothing out Level Measurement Problems with the Robertshaw Level-Tel

PROBLEM: How to measure bin level changes *accurately* in hot, hard-to-handle, extremely abrasive materials.

SOLUTION: The Robertshaw Level-Tel continuous level indicator.

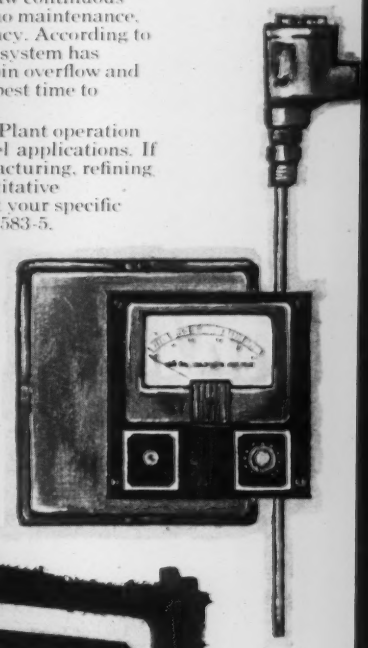
EXAMPLE: The four hot gravel bins at the Valley Asphalt Plant, City of Los Angeles, are relatively inaccessible, too hot to touch and contain no open ports. Reaching deep into each of the bins, a probe specifically designed for rugged duty continuously detects the changing gravel level and, by means of a simple capacitance bridge, relays the information to the plant control room. Previously, the operator had no way of knowing accurately the gravel level in each bin prior to mixing with liquid asphalt. Blacktop from the plant is used for road repair throughout California's burgeoning San Fernando Valley.

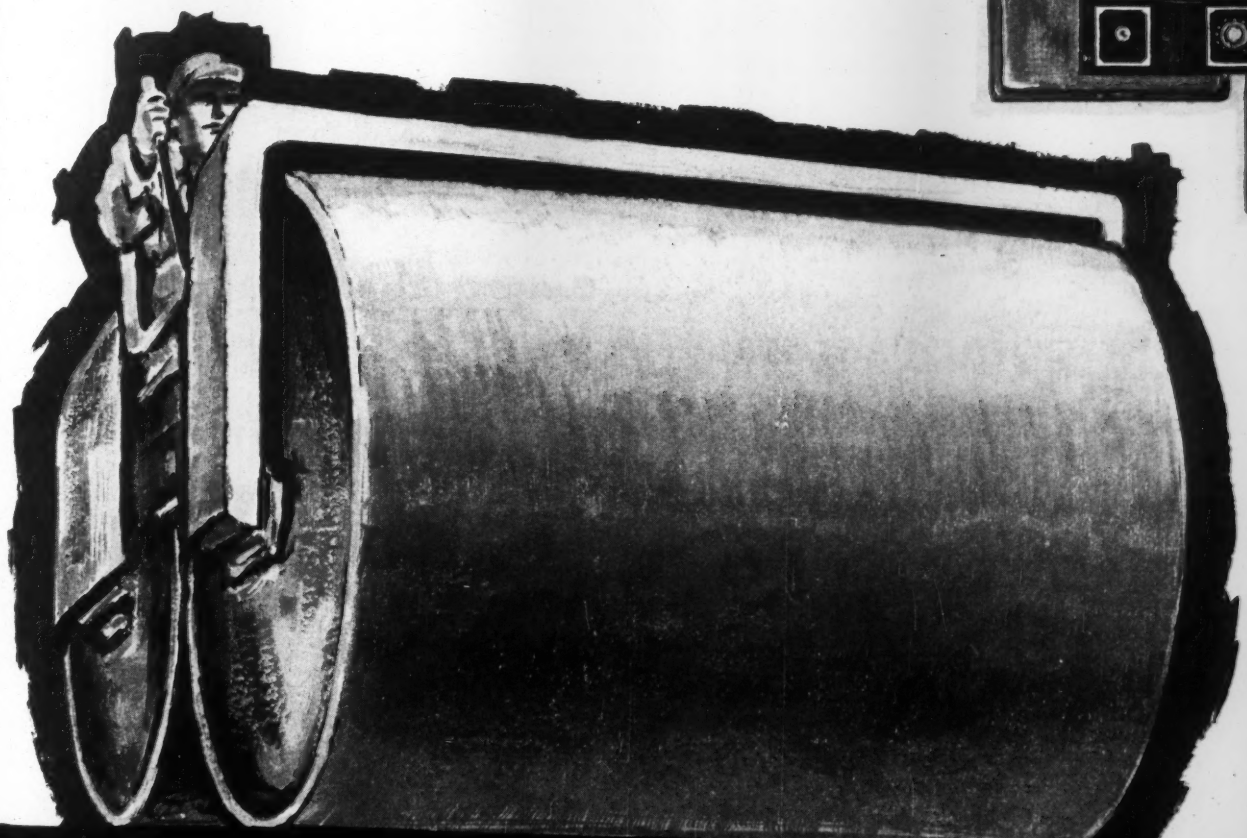
Installed two years ago, the Robertshaw continuous level measuring system has required no maintenance, while performing with extreme accuracy. According to Valley Plant engineers, the Level-Tel system has speeded up plant operation, reduced bin overflow and enabled them to determine easily the best time to change formulations.

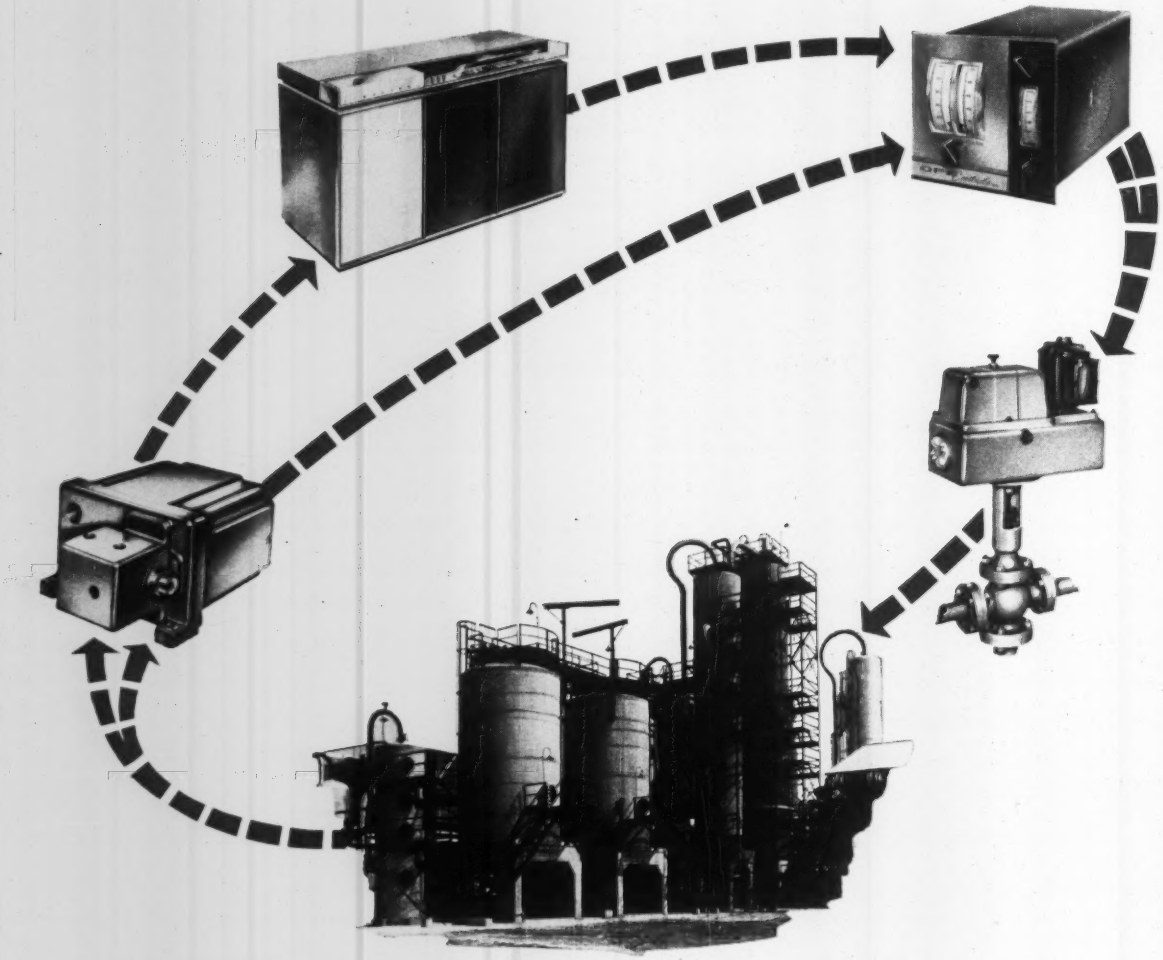
SUGGESTION: The Valley Asphalt Plant operation is just one of many possible Level-Tel applications. If you are engaged in processing, manufacturing, refining or mining, there's a Robertshaw quantitative measurement and control system to fit your specific requirements. Write for Bulletin RF-583-5.

Aeronautical & Instrument Division, Robertshaw-Fulton Controls Company, Santa Ana Freeway at Euclid Avenue, Anaheim, California.

For more information circle **11** on inquiry card.







GPE Controls can close the loop in computerized process control

You can realize the benefits of modern computerized process control—today—because GPE Controls, Inc. can supply closed-loop system components manufactured by its own divisions and designed to operate together.

- **Transmitters for process variables, and controllers—made to operate with computers**
- **The Libratrol-500 digital computer . . . with built-in analog-to-digital input and digital-to-analog output**
- **Link expandable special-purpose data-processing systems**
- **Electro-hydraulic valve actuators from 200 to 200,000 lbs. thrust**

These performance-matched components, coupled with a quarter-century of experience in industrial automatic controls, assure optimum performance whether you need a closed-loop system or an expandable data-processing system.

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Write for information on this unique GPE Controls service

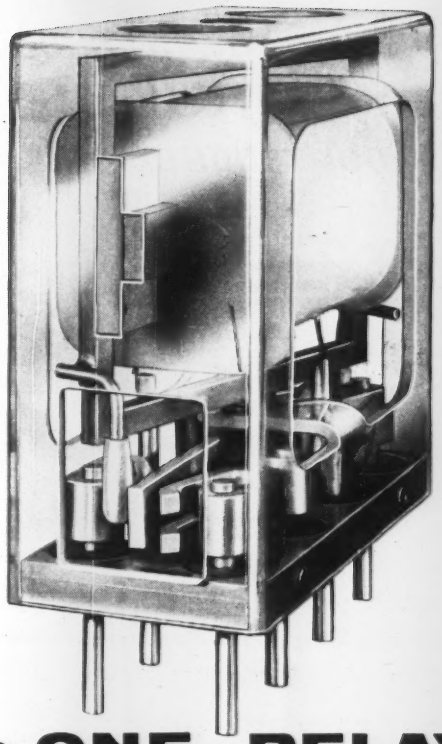
GPE Controls, Inc. (formerly Askania Regulator Company)
240 East Ontario Street • Chicago 11, Illinois

A Subsidiary of GENERAL PRECISION EQUIPMENT CORPORATION

For more information circle **12** on inquiry card.

4 times actual size

Mock-up of CLARE Type F Relay enlarged to show operating mechanism. Note bifurcated contacts which enable this relay to handle a wide variety of contact loads.

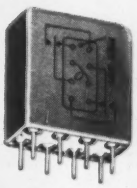


With this ONE RELAY

You can handle contact loads from 3 amperes down to 1 microampere, 1 millivolt

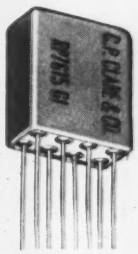
SPECIFICATIONS

Ambient Temperature	—65° C to +125° C.
Shock	65 Gs for 11 milliseconds.
Vibration	5-75 cps at maximum excursion of ⅛ inch, 75-2000 cps at 20 Gs acceleration.
Dielectric Strength	Sea level—1000 volts rms between terminals and frame, and between adjacent circuits; 750 volts rms between contacts of a set. At 80,000 ft., 350 volts rms.
Insulation Resistance	1000 megohms minimum at 125° C.
Coils	Coils up to 10,000 ohms available for a wide range of voltage or current operation.
Nominal Operating Power	250 milliwatts.
Pickup Time	3.5 milliseconds nominal.
Dropout Time	1.5 milliseconds nominal.
Contact Arrangement	2 pdt (2 form C).
Contact Rating	3 amps resistive at 28 volts d-c or 115 volts a-c; also will handle loads of 1 microampere @ 1 millivolt reliably.
Contact Resistance	0.03 ohm maximum.
Contact Life	500,000 operations minimum at 2 amps; 100,000 operations minimum at 3 amps; 1,000,000 operations minimum at 1 amp.
Enclosure	Hermetically sealed, filled with dry nitrogen at 1 atmosphere pressure.
Mounting	All popular mounting arrangements available.
Terminals	Printed circuit; solder; plug-in (matching socket available). Variations of printed-circuit terminal length on 1/10-inch grid spacing available.
Weight	17 grams.
Military Specifications	MIL-R-25018, except as to contact bounce.



ACTUAL SIZE

All popular mounting arrangements are available. Terminal arrangements nicely suited to 1/10 inch grid spacing.



• In one relay—the Type F—CLARE provides a precise component of unusual flexibility for long life operation under a wide variety of contact loads.

Tests have shown a performance of over 22,500,000 operations at 0.1 ampere, 115 volts a-c. Minimum contact life at 3 amperes is 100,000 operations. Contacts have carried 1 microampere, 1 millivolt for 700,000 operations with a failure resistance of 500 ohms, with no misses recorded.

This amazing low-level life is primarily a result of the use of gold plated contacts. These same contacts, however, will carry up to 3 amperes.

A special plug-in mounting arrangement that will stand extreme shock and vibration is now available.

The CLARE Type F Relay is hermetically sealed, operates perfectly in a wide range of temperatures, withstands heavy shock and vibration—is fast and more than moderately sensitive.

Send for Engineering Bulletin No. 124

Write or call C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable Address: CLARELAY.

CLARE RELAYS

FIRST in the industrial field

For more information circle **13** on inquiry card.

here's how to specify

DEKORON INSTRUMENT HARNESS

to fit your requirements exactly

ALUMINUM OR COPPER / POLYETHYLENE OR NYLON + plastic sheath = DEKORON METL-COR / DEKORON POLY-COR — **FOR CORROSION RESISTANCE**

DEKORON METL-COR / DEKORON POLY-COR + steel armor = ARMORED METL-COR / ARMORED POLY-COR — **FOR IMPACT AND CORROSION RESISTANCE**

ARMORED METL-COR / ARMORED POLY-COR + plastic sheath = ARMORED METL-COR, Plastic Overall / ARMORED POLY-COR, Plastic Overall — **FOR IMPACT AND MAXIMUM CORROSION RESISTANCE**

ALUMINUM OR COPPER / POLYETHYLENE OR NYLON + insulating tape + steel armor = ARMORED TUBES — **FOR IMPACT RESISTANCE IN DRY LOCATIONS**

ARMORED TUBES + plastic sheath = ARMORED TUBES, Plastic Overall — **FOR CORROSION AND IMPACT RESISTANCE**

No matter what your special environmental requirements for instrument tubing may be—no matter how stringent for corrosion, impact or fire resistance—there's a type of Dekoron instrument line harness to *satisfy them exactly*. In most cases you can get *delivery from stock*. And *all* Dekoron products have three things in common: Highest quality materials and construction . . . lowest possible installation cost . . . longest life of any instrument line harness. That's *Dekoron—America's Premier Instrument Tubing Line.*

AA-8354

Dekoron® products

SAMUEL MOORE & COMPANY

DEKORON PRODUCTS DIVISION • MANTUA, OHIO

QUALITY • RESEARCH • SERVICE

For more information circle **14** on inquiry card.

trends

There are about 4000-5000 analog-computer installations (both general-purpose and special-purpose) in Russia, says E. Grabbe, after tour of Russia. This includes about 1000 units of a general-purpose computer (d-c equipment with chopper stabilization), and 300 of a special-purpose transistorized machine for 6th-order equations (model MN-M). INSTRUMENTS AND CONTROL SYSTEMS estimates that USA now has about 1200 general-purpose EDA's installed.

Environmental test equipment market in 1959 will be $10-$20 million says M. Seligman, President, Tenny Engineering. Cost of electronic gear in test chambers is now 5-20% (average 10%).

Total weight of silver used in the free world in 1958 was 250.5 million troy ounces (compared to 289.4 million in 1958), reports American Smelting & Refining Co. More than half went into industrial use. USA industrial market includes about 30 million ounces in photography, 24-27 million for silver soldering and brazing alloys, 18-20 million electrical contacts, ceramic outlets including printed circuits—1.0-1.3 million, silver-zinc batteries—1.5 million. Other uses include catalyst, water sterilization and treatment, oil and cutting fluid treatment, engine bearings, control rods for reactors, desalting sea water, dental alloys, mirror and thermos bottle backing, pharmaceuticals (antiseptics and germicides), autoclave and vat linings, seed fungicide. Silver quotations in N. Y. averaged 89.044 cents/tr oz in 1958, compared to 90.820 in 1957.

Missile and aircraft electronics volume in 1959 may reach $3 billion (compared with $2.3 billion in 1958) says S. F. Keating, Minneapolis-Honeywell.

Closed-circuit TV market was $7 million in 1957, $8.2 million in 1958, and will reach $13 million in 1959, says Electronics magazine.

Analog computer market is firm. Electronic Associates reports that its 1958 sales reached $14.5 million, compared to $10.5 million for 1957, and expected $18-$20 million for 1959.

Power reactor R&D program of U.S. Euratom will spend $100 million in its first five years. Improved instrumentation is one goal.

Electron tube sales should reach $866 million in 1959 (compared to $800 million in 1958) says D. Y. Smith of RCA.

Pentagon reports that total net value of military prime contracts totaled $21.794 billion in FY 1958, of which $16.164 billion (74.2%) went to top 100 prime contractors. Percentage was 68.4% in FY 1957.

More than 1200 digital computer installations are now operational in USA, reports American Management Association.

Engineered WEIGHING SYSTEM NEWS

HYDRAULIC CELLS "NATURALLY" DAMPEN OUT OSCILLATIONS OF VIBRATORY LOADS

Precision weighing of a vibratory load poses a troublesome problem for the instrument man. This is particularly true if the oscillations of the vibrations are irregular in both magnitude and time.

Where effort is made to use electrical load cells to do this job, filters are employed. In many instances, the drift of the filter is greater than the desired measurement.

Engineering-wise it is a well-known fact that oil has within itself the natural property of dampening out vibrations. This, plus the proper engineering of tubing and valves, make the Emery Engineered Weighing System the most effective method available today for solving the problem of dampening out troublesome vibrations to give precision weighing of vibratory loads.

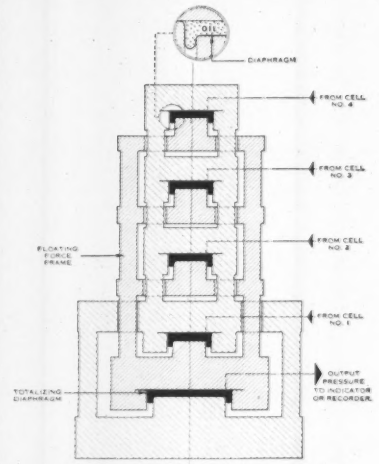
When writing, refer to Item 1009

WAY-PAC LOAD TOTALIZER UNIT COMBINES HYDRAULIC CELL LOADS

The new, simple, self-contained Emery WAY-PAC Load Totalizer Unit, a device for combining the loads on two, three, or four WAY-PAC Cells, has a sensitivity of 1 part in 5,000 and will accept the maximum capacities of both the 1,000 lb. and the 5,000 lb. cells. It is shock resistant, weather-proof, and is not affected by temperature variations.

Measuring 9½" in overall height, the totalizer contains diaphragms each of which exerts a load on a floating force frame. The force frame, in turn, exerts this total load on the totalizing diaphragm where it is again converted into a combined output hydraulic pressure which represents the combined load on two, three, or four WAY-PAC cells. All types of indicating, recording and controlling instrumentation may be used in conjunction with the WAY-PAC Load Totalizer.

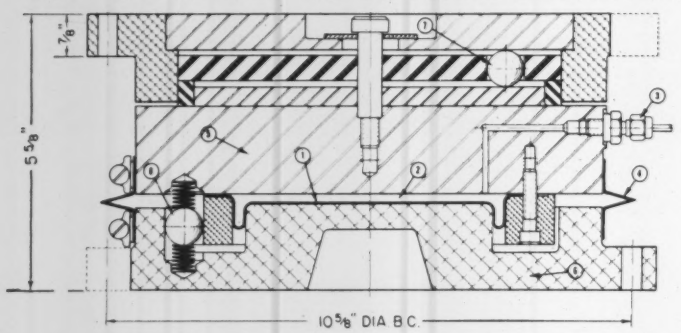
When writing, refer to Item 1006



WAY-PAC LOAD TOTALIZER

The new WAY-PAC Load Totalizer combines the loads on two, three or four WAY-PAC Load Cells.

WAY-PAC HYDRAULIC CELL LINE IS NOW EXPANDED TO 5,000 LB. CAPACITY



1 DIAPHRAGM 2 OIL 3 OIL FITTING 4 PROTECTIVE BOOT (neoprene)
5 BAR STOCK ALUMINUM 6 CAST ALUMINUM 7 ROLLING BALL 8 POSITIONING BALLS

Cross section of the new 5,000 lb. capacity WAY-PAC Compression Cell with the exclusive Emery "rolling ball head" (Type AC-5-RB).

The recently-introduced line of Emery WAY-PAC Hydraulic Load Cells has now been expanded to include capacities of 5,000 lbs. The original WAY-PAC line was limited in its rating up to 1,000 lbs.

The WAY-PAC 5,000 lb. cells are similar to the previous 1,000 lb. cells in manufacture but the new dimensions are different. Included in the line are: the AC-5, Compression; the AC-5-RB, Compression with "rolling ball" head; the AU-5, Tension; the AT-5, Cable Tension; and the AD-5, Strut Cell. The same instrumentation which teams up so well with the 1,000 lb. series works equally well with the new 5,000 lb. line.

When writing, refer to Item 1008

NEW 19½" DIAL INDICATOR WILL IMPROVE ACCURACY OF CELL PRESSURE READINGS

Taking pressure readings with increased accuracy is much easier with the new Emery 19½" dial indicator. Previously, the largest dial offered measured 16½" in diameter.

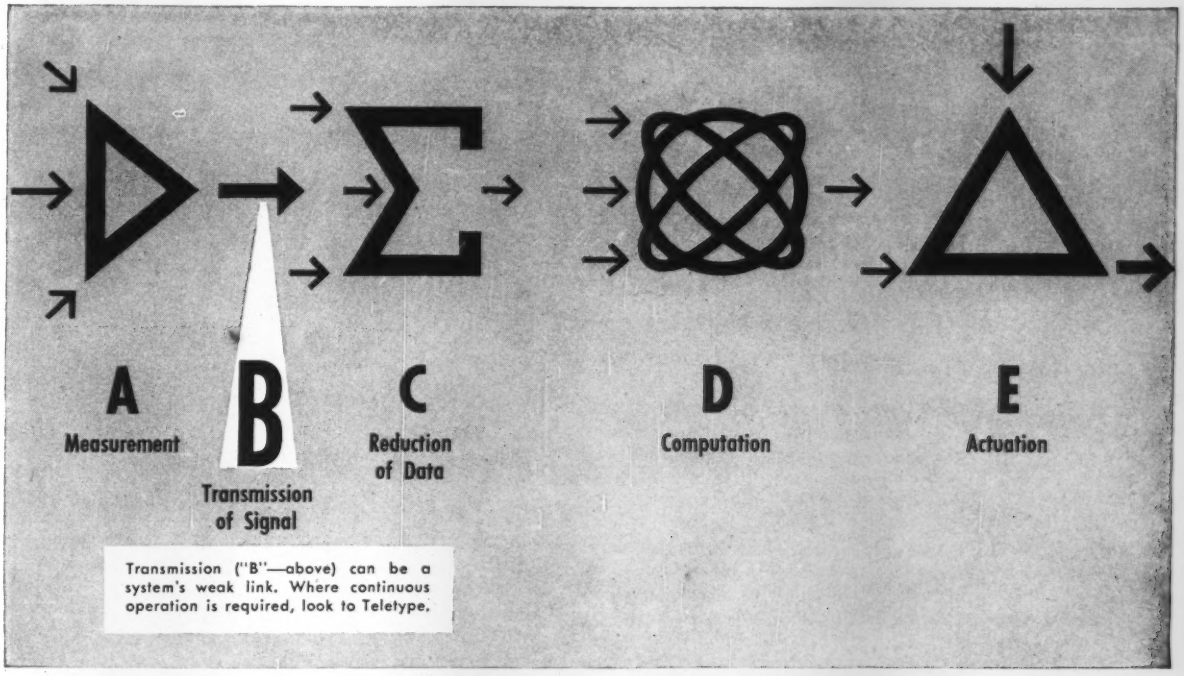
Since the basic objective of dial reading is accuracy, our 19½" indicator makes possible greater accuracy than ever before. Because of the larger scale length, graduations can be better matched to the job. Easy and accurate readings are a basic advantage with the new Emery 19½" indicator.

When writing, refer to Item 1007

The A. H. Emery Co., New Canaan, Conn.
I am interested in the following:
Item 1006 ☐ Item 1008 ☐
Item 1007 ☐ Item 1009 ☐
Seeing Representative ☐
Name .....
Title .....
Company .....
Address .....
City ..... State .....

THE A. H. EMERY COMPANY
New Canaan, Conn.
Engineered WEIGHING SYSTEMS

For more information circle **15** on inquiry card.



Teletype — Symbol for continuous operation

Teletype equipment was born to demanding applications; railroad stations located too far for servicing, 24-hour newspaper and telegraph jobs, the stock exchange where a breakdown could cost a fortune . . . and rough hitches with the armed forces.

The Model 28 printer incorporates Teletype dependability with a host of new features for communication and data processing applications.

Attention Free. The Teletype Model 28 printer is designed for minimum maintenance. Lubrication interval at 100 word per minute speed is 1,500 hours—at 60 word per minute it's 3,000 hours! Motors were specially designed for the Model 28, to give long, attention-free operation. The printer is not affected by tilting or severe vibration, works reliably even in mobile applications. Other attention-free features:

1 New type box. Characters are contained in a compact, lightweight assembly. Each character is on a separate pallet—type alignment is built in, overscoring and underscoring eliminated. The type box can be quickly removed, without tools, for cleaning or changes in type arrangement.

2 Tests at 100 WPM in continuous operation show 9,000,000 words printed, without servicing. Paper guides and pressure rollers are designed to provide straight-line paper feed, insuring accurate, continuous, paper alignment.

3 All steel clutches give firm, uniform, and accurate engagement, cycle after cycle . . . operate with exceptional stability . . . deliver high torque capable of handling positive and negative loads. Internal expansion principle in clutch design minimizes wear. Lubrication interval is reduced to once or twice a year.

New—Versatile, too. The Teletype Model 28 printer is a new instrument . . . engineered to "cruise" at 100 WPM. It is attractively styled and quiet in operation.

Exclusive with the Teletype 28 Printer is the versatile Stunt Box, which is actually a "robot brain." Responding to keyboard or line signals, it may be used for internal control of extra functions in the Teletype printer and for remote control of associated or other electronic or mechanical equipment.

For more information about this Teletype Model 28 printer—write to Teletype Corporation, Dept. 23C, 4100 Fullerton Ave., Chicago 39, Illinois.

TELETYPE®
CORPORATION
SUBSIDIARY OF *Western Electric Company* INC.

For more information circle **16** on inquiry card.

news

Humble Oil & Refining Company to Install Analog Computer System

BAYTOWN, TEXAS—Early this spring Humble Oil & Refining Company will acquire under long-term lease, one of the largest, most modern analog computer facilities ever used by industry. The system will be manufactured by Mid-Century Instrumatic Corp., New York City.

The facility at Humble's Baytown, Texas, Refinery will be utilized in research and development of new processes, optimization of existing refinery operating units, and to speed and improve process and mechanical design in all phases of the company's operations. Nucleus will be two Mid-Century MC-5900 Master Process Analog Computer consoles. An Automatic Digital Recording and Control System (ADRAC) will assist the computer operator by automatically setting and/or checking nearly 5,000 control, switch and interconnection settings associated with the two consoles. Operators will feed instructions to the ADRAC in the form of punched paper tape or manually through a typewriter keyboard.

The facility will include 202 operational amplifiers, 60 electronic multipliers, 20 diode function generators, transport delay units, electronic digital voltmeters, pen-and-chart recorders and other miscellaneous output equipment for display of problem solutions. It will be housed in a series of consoles fifty feet long weighing over ten tons.

Tape in Satellite Watches Weather

DANBURY, CONN.—Video Tape (Made by Reeves Soundcraft) is being used by the video recorder in the Vanguard Satellite launched Feb. 16. The Satellite is being used to scan the cloud pattern under its orbit.

Two photoelectric cells, each covering about 40 square miles of the earth's surface, transmit their photographic observations to the tape recorder where they are stored on the tape. The observations are then transmitted to ground observation control.

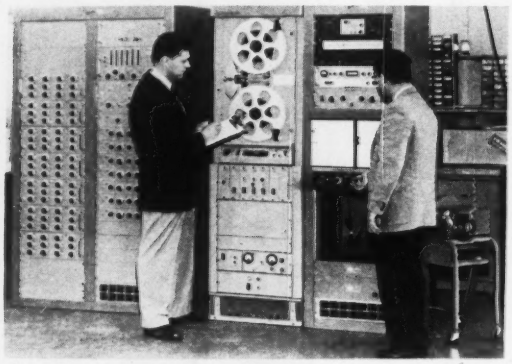
This is the first known attempt to take pictures of the earth's weather formations from outer space.

Major Behar Honored Posthumously

PITTSBURGH, PA.—The Pittsburgh Section ISA presented a donation of $100.00 to the Heart Fund in memory of the late Major Behar. Ben Fogleman, president of the Pittsburgh Section, made the presentation at a recent meeting; Mr. Richard M. F. Young, executive director of the Western Pennsylvania Heart Association accepted for the Heart Fund.

New Data System

PASADENA, CALIF.—This seven-channel record-playback (Wiancko Engineering designed) system simplifies plotting pressure transients in an X-Y plotter



while simultaneously digitizing the information. The digitized values are punched out on paper tape. The system will be used for acceptance testing the Navy's Polaris Missile program on dry land prior to shipboard handling.

Aronson Keynotes NSTA Meeting

NEW YORK, N. Y.—Dr. Harold Spielman, City College of N. Y., announces that the 1959 Convention of the National Science Teachers Association will be held in Atlantic City, March 31-April 4. A symposium on Implications of Automation for the Teaching of Science will be held on Friday, April 3, Ambassador Hotel. Milton Aronson, editor of *INSTRUMENTS & CONTROL SYSTEMS*, will be the keynote speaker.

Computer Operated Control Systems

DES PLAINES, ILL.—Cooperative effort by Daystrom, Incorporated and Universal Oil Products Company has resulted in successful pilot plant applications of the first computer-operated control system for continuous processing, it was stated in a joint announcement by the two companies. This accomplishment resulted from several years of coordinated activity by Daystrom and Universal. It is additionally expected to broaden the applications for continuous processes by controlling operations too complex for previously available systems.

CUBIC CORP. recently received the visit of a French military delegation that discussed progress in France's missiles development program and the company's tracking system.

MONSANTO CHEMICAL CO. will put the industry's "first computer-controlled chemical plant" on stream during 1959. The computer installation will be the result of a joint study by Monsanto's systems engineering group and The Thompson Ramo Wooldridge Products Co., and will use an RW-300 digital control computer.

ASCO Close-Differential Relays provide dependable, low-cost protection from under and over voltage.

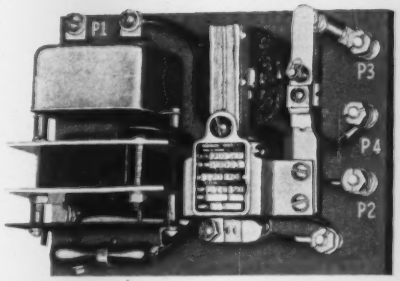
When a motor runs on low voltage for an extended period of time, burnout and fire may result. This can be costly in both down-time and damage to equipment.

You can protect your motors with ASCO Close-Differential Relays. They offer economical, dependable protection even when motor feedback conditions prevent ordinary potential relays from detecting changes in voltage. ASCO Close-Differential Relays respond to a 2% variation in voltage; protect motors when low voltage or over voltage conditions occur.

Because they combine sensitivity with rugged construction, ASCO Relays are providing low-cost protection in a wide variety of applications.

For example, in some oil burner installations, ASCO Relays help prevent explosions due to under voltage. In these installations, when under voltage occurs, ASCO Relays prevent oil build-up in the pit by detecting this low voltage condition, and causing oil flow to be cut off immediately. Otherwise on under voltage the oil would build-up in the pit since the ignition system would not fire. This excess oil could result in an explosion when voltage is restored and the ignition system fires.

Find out how the ASCO Close-Differential Relay can protect your equipment. Send for Catalog 57-S4 describing the complete line of ASCO Relays.



ASCO Close-Differential A-C Relay operates on 2% variation in voltage – features positive action, quiet operation, power relay type contacts.

Dependable control by ASCO is available from representatives and distributors in all principal cities.

Automatic Switch Co.

52F Hanover Road, Florham Park, New Jersey • Frontier 7-4600

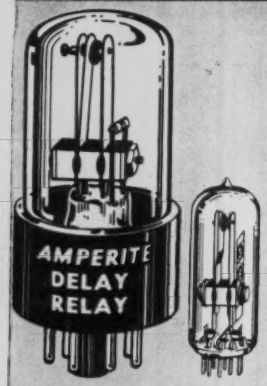
AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL

ASCO®

For more information circle **17** on inquiry card.

AMPERITE

THERMOSTATIC
DELAY RELAYS



2 to 180 Seconds

Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.

Hermetically sealed. Not affected by altitude, moisture, or climate changes.

SPST only—normally open or closed.

Compensated for ambient temperature changes from —55° to +70° C. Heaters consume approximately 2 W. and may be operated continuously. The units are rugged, explosion-proof, long-lived, and—inexpensive!

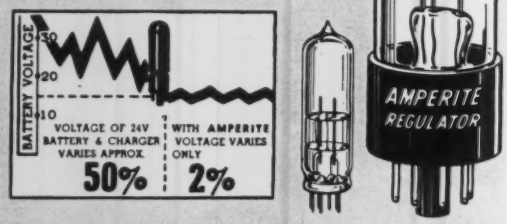
TYPES: Standard Radio Octal, and 9-Pin Miniature . . List Price, $4.00. Standard Delays

Also — Amperite Differential Relays: Used for automatic overload, under-voltage or under-current protection.

PROBLEM? Send for Bulletin No. TR-81

AMPERITE
BALLAST REGULATORS

Amperite Regulators are designed to keep the current in a circuit automatically regulated at a definite value (for example, 0.5 amp.) . . . For currents of 60 ma. to 5 amps. Operate on A.C., D.C., or Pulsating Current.



Hermetically sealed, they are not affected by changes in altitude, ambient temperature (—55° to +90° C.), or humidity . . . Rugged, light, compact, most inexpensive . . . . . List Price, $3.00.

Write for 4-page Technical Bulletin No. AB-51

AMPERITE

561 Broadway, New York 12, N. Y. . . . . CAnal 6-1446

In Canada: Atlas Radio Corp., Ltd., 50 Wingold Ave., Toronto 10

For more information on Delay Relays circle **18** on inquiry card.
For more information on Regulators circle **19** on inquiry card.

NEWS—CONTINUED

TENNEY ENGINEERING has installed (at the U. S. Army's Frankford Arsenal) a new environmental test chamber which can produce any type of rainfall, from a drizzle to a deluge, and when the rain stops, a typical clear-bright day with the sun's rising and setting can be simulated.

NBS has developed a non-destructive technique for measuring the true internal resistance of dry cells by applying a repetitive pulse. Results of such tests show that increase of internal resistance depends on the type of discharge, cell size, and variations in manufacture.

POOL, the corporation users association for the **Royal Precision** LGP-30 computer will hold its second annual meeting April 14, 15 and 16 at the Mayflower Hotel in Washington, D. C.

THE FOXBORO COMPANY is installing a 72" magnetic flow meter, the world's biggest, at the new Allegheny County Sanitary Authority sewage treatment plant at Pittsburgh, Pa. Range is up to 350 mgd.

Foxboro 72"
Magnetic Flowmeter

Leeds & Northrup's
Chromomax Analyzer

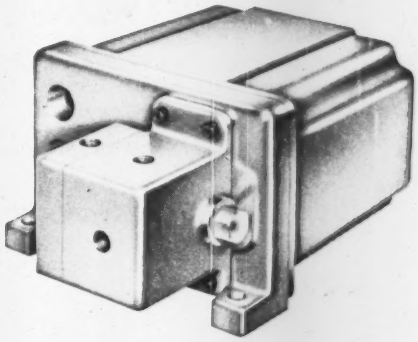
LEEDS & NORTHRUP's Chromomax gas chromatography analyzer has helped *Pennsalt Chemicals Corp.'s* Calvert City, Kentucky, Isotron plant reduce impurities in refrigerants and aerosol propellants. Connected directly to the process stream only a few feet away from the control room, this analyzer provides up-to-the-minute data on purity. Impurity levels as low as 0.01% are thus detected.

In a unique application at **Electric Boat Division** of **General Dynamics Corp.**, Groton, Connecticut, a Mid-Century Analog Computer controls a mock submarine trainer which will start up, dive, turn, climb, run into rough weather, fire torpedoes, develop a leak or engine failure, or other simulated casualties when instructions for their maneuvers are fed into the computer, which responds as a submarine would under similar circumstances.

INTERCHANGEABILITY of magnetic tape recordings throughout the world is the purpose of a new international standards recommendation of the International Electrotechnical Commission (IEC), available in the United States through the American Standards Association (ASA). The standard is contained in IEC Publication 94—"Recommendations for Magnetic Tape Recording and Reproducing Systems: Dimensions and Characteristics." ($2.40, American Standards Association, 70 E. 40th St., New York 17, N. Y.)

New from **GPE Controls...**

Model 776F **Flow Transmitter** has the lowest differential pressure requirement of any transmitter...as low as 3" w.c. for maximum output of 25 volts d.c. at power levels up to 5 watts. Permits use of larger orifices; transmission over as much as 5 miles; simultaneous operation of controllers, recorders, analog-to-digital converters. Automatically extracts square root for straight summarization of flows. Also Model 776D for differential pressure transmission.



GPE Controls | A GENERAL PRECISION COMPANY

Write for descriptive literature

GPE Controls, Inc. (formerly Askania Regulator Company)
240 East Ontario Street • Chicago 11, Illinois

A Subsidiary of GENERAL PRECISION EQUIPMENT CORPORATION

For more information circle **20** on inquiry card.

MINOXO INDICATOR

SUPER-SENSITIVE DEOXO INDICATOR

for detection and measurement of oxygen or hydrogen impurities in other gases

MINOXO INDICATOR . . . measures traces of molecular oxygen in other gases—from 1 to 10 parts per million, and from 1 to 100 PPM. High sensitivity and rapid speed of response enable it to be used for laboratory investigation and production quality control.

SUPER-SENSITIVE DEOXO INDICATOR . . . measures oxygen or hydrogen present as impurities in other gases—from 2 to 200 parts per million oxygen and 4 to 400 parts per million hydrogen. Dual range permits measurement up to .25% oxygen or .50% hydrogen. Send for literature.

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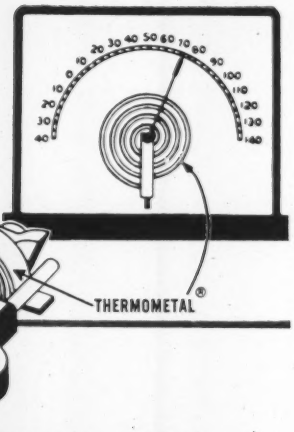
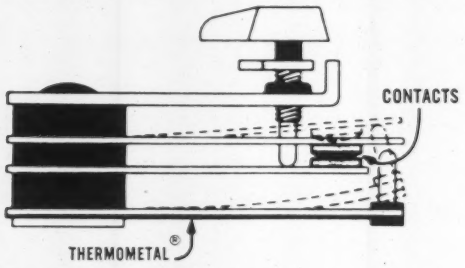


THERMOMETAL® for dependable temperature, electrical current and voltage control applications



Leading manufacturers depend upon the outstanding performance of Thermometal in electrical appliances, thermal cutouts, heating controls and many other applications involving the indication and accurate control of temperatures, electrical currents, voltages, etc. Thermometal is supplied in strip form, rolled and slit to close tolerances and tempered to specification. Thermometal elements and sub-assemblies are also supplied to specifications, with or without contacts attached. Send for literature.

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CHEMICAL DIVISION

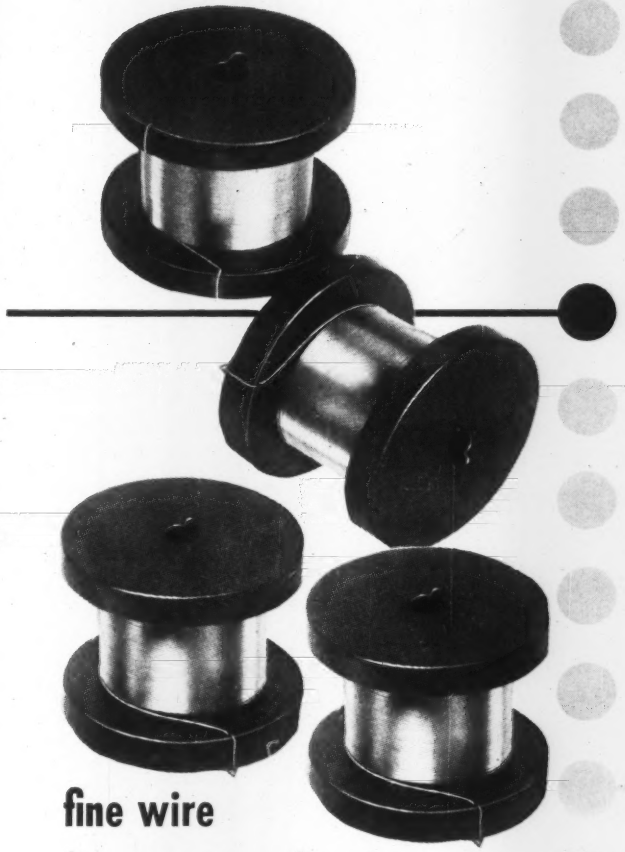
WRITE FOR LITERATURE

H. A. WILSON DIVISION

DOMESTIC DIVISIONS: AMERICAN PLATINUM & SILVER DIVISION, AMERSIL QUARTZ D VISION, BAKER CONTACT DIVISION, BAKER DENTAL DIVISION, BAKER SETTING DIVISION, BAKER PLATINUM DIVISION, CHEMICAL DIVISION, EAST NEWARK INDUSTRIAL CENTER, HANOVIA LAMP DIVISION, HANOVIA LIQUID GOLD DIVISION, IRVINGTON-BAKER REFINING DIVISION, D. E. MAKEPEACE DIVISION, NATIONAL ELECTRIC INSTRUMENT DIVISION, RESEARCH AND DEVELOPMENT DIVISION, H. A. WILSON DIVISION. COMPANIES ABROAD: ENGELHARD INDUSTRIES OF CANADA, LTD. TORONTO, ENGELHARD INDUSTRIES OF QUEBEC, LTD. MONTREAL, ENGELHARD INDUSTRIES, LTD. LONDON, ENGELHARD INDUSTRIES A. G. ZURICH, ENGELHARD INDUSTRIES PTY., LTD. MELBOURNE, SOCIEDAD SURAMERICANA DE METALES PRECIOSOS S. A. BOGOTA, INDUSTRIE ENGELHARD S. P. A. ROME, ENGELHARD INDUSTRIES OF SOUTHERN AFRICA, LTD. JOHANNESBURG. ASSOCIATED COMPANIES: ACME TIMBER INDUSTRIES LTD., SOUTH AFRICAN FOREST INVESTMENTS LTD., SOUTH AFRICA, AZOPLATE CORPORATION, CHARLES ENGELHARD, INC., NUCLEAR CORP. OF AMERICA, INC., U.S.A.

For more information on Indicator circle **21** on inquiry card.

For more information on Thermometal circle **22** on inquiry card.



fine wire for every application

Here, you will find a thoroughly dependable source for fine wire of ductile and non-ductile materials for every application. Special processes have been developed for bare drawing wire as fine as .0004". Where smaller fine wire is required, the Wollaston Process for ductile metals and the Taylor and Extrusion methods for non-ductile materials are employed. All standard fine wire requirements are stocked for prompt delivery. Full facilities are available for the production of fine wires made to your own specifications.

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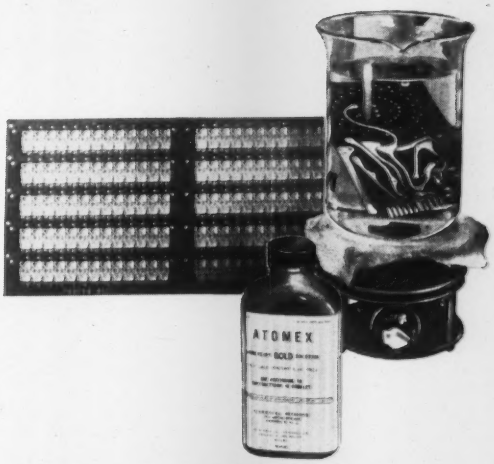
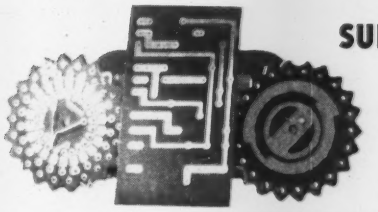


gold and rhodium plating for corrosion-resistant surfaces



ATOMEX® is a 24k gold immersion solution that permits the deposition of a thin, dense, uniform layer of 24k gold on printed circuits and metallized plastics by means of a simple bath. The Atomex procedure is more permanent and less expensive than electroplating of comparable thickness. Costly analytical control is unnecessary.

Rhodium—a complete line of plating solutions are also available for high-reliability electrical and electronic applications. Rhodium is highly resistant to corrosive atmospheres, oxidation and arc erosion—reduces wear on moving surfaces—assures low noise level for moving contacts, no oxide rectification, low and stable contact resistance. Rhodium plating is indicated when a low-resistance, long-wearing, oxide-free contact is required. Send for literature.

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For more information on Wire circle **23** on inquiry card.

For more information on Rhodium Plating circle **24** on inquiry card.

TO UPGRADE INSTRUMENTATION . . .

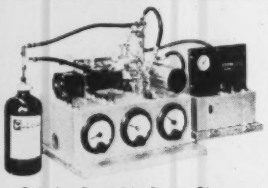
Kollsman specified Cobehn spray-clean equipment

To critically clean precision instrument bearings for assembly in navigational instrumentation, Kollsman Instrument Corporation, Syosset, N.Y., specified Cobehn automatic parts cleaner. The unit installed *(illustrated in operation above)* automatically, safely and economically removes bearing contaminants; critically cleans 2400 bearing components an hour, unit cost is approximately 3 mils.

Cobehn precision parts cleaners are engineered to critically clean semi-conductors, gear clusters, bearings, switches, relays and other small electronic and electromechanical components on a continuous production schedule. Oil, grease, silicone lubricants, rosin flux and other foreign matter are safely and economically removed in seconds.

The Cobehn cleaning method provides:

- **a) Uniformity in cleaning technique;**
- **b) Close control over solvent costs;**
- **c) Controlled rotation of parts during cleaning;**
- **d) Elimination of chilling and condensation;**
- **e) Chemically cleaned parts without film, residue or corrosive effect. (Fractionally distilled Cobehn solvent far exceeds Fed. Specification P-S-661 b);**
- **f) Integral ventilation system.**



Cobehn Portable Parts Cleaner
Model No. 1-2BC-2S-2

For specific information about your critical cleaning problems, send product information and production requirements. Our engineering report will be forwarded without delay.

Cobehn® Inc.
226 Passaic Avenue
Caldwell, New Jersey

For more information circle **25** on inquiry card.

stock report

Any further information concerning any of the following issues may be obtained from the Research Department, Bache & Co., 36 Wall Street, New York 5, N. Y.

American Stock Exchange:

PRICE RANGE 1958-59 THRU FEBRUARY 16, 1959

	HIGH	LOW	PRICE AS OF 2/16/59
American Meter	45	27 5/8	43 1/4 (1)
Arc Equipment	24 1/2	13 3/4	23
Barry Controls "B"	17	4 3/8	14 1/4
Belock Instruments	14 1/4	7 3/8	13
Benrus Watch	7 1/2	4 7/8	6 3/4
Breeze Corp.	7 1/8	5 1/8	6 1/2
Clark Controller	24	14 7/8	21 1/8
Clarostat Mfg.	5 5/8	2 7/8	5
Clary Corp.	7 3/4	2 7/8	7 1/4
DuMont Laboratories	8 1/4	3	6 3/8
Dynamics Corp. of America	6 1/4	2 7/8	5 3/4
Electronics Corp. of America	16 1/4	6 3/8	11 3/8
El-Tronics	3 3/4	5/8	1 1/2
Fairchild Camera & Instrument	73 1/2	19 1/2	72
General Transistor	67 1/4	17 1/4	59 1/8
Globe-Union	24 3/8	14 5/8	21 1/2
Hazeltine Corp.	62 3/8	30 1/2	57
International Resistance	9 1/2	3 3/4	7 7/8
Lear, Inc.	11 1/2	4 1/4	11 3/8
National Research	27 7/8	12 7/8	23 1/2
Neptune Meter	36 1/8	19 1/2	34 1/4
New Haven Clock	3 1/4	7/8	1 7/8
Nuclear Corp. of America	4 1/4	7/8	2 7/8
Philips Electronics Inc.	28	11	25
Pneumatic Scale	67	18 1/2	49 1/4
Servo Corp. of America	22 3/8	3 3/4	22 3/8
Servomechanisms	11 3/4	6 5/8	9 7/8
Statham Instruments Inc.	28 3/4	13 5/8	23 3/4-24 1/4(1)
Wallace & Tiernan	40 3/4	24	37 1/2
Victoreen Instrument Co.	9 1/8	3 3/4	7 1/4
Waltham Prec. Instrument Co.	2 7/8	13/16	2 3/8

1- Not Traded-Bid and Asked

New York Stock Exchange:

Price Range for 1958-59 Thru February 16, 1959

	HIGH	LOW	PRICE AS OF 2/16/59
ACF Industries	55	27 1/8	55
Aeroquip Corp.	28 3/4	16 7/8	26 7/8
Allis Chalmers	30 1/8	22 1/8	27 1/4
American Chain & Cable	55	29 1/2	52
American Machine & Foundry	61 3/4	32 1/4	60 7/8
American Machine & Metals	64	47 1/2	77
American Optical	44 1/4	34 3/4	43 3/4
American Tel. & Tel.	240 1/2	167 7/8	236 3/4
Ampex Corp.	73 3/4	67 3/4	71
Bausch & Lomb Optical	36	23	28 3/8
Beckman Instruments	47 1/8	18 1/8	46
Bell & Howell	94 7/8	42	76 1/4
Bendix Aviation	74 1/2	44 1/2	72 1/2
Boeing Airplane	58 1/8	34 1/8	40 1/2
Bullar	20 3/4	10	19
Bulova Watch	16 3/4	9 3/4	14
Burroughs	43 3/8	27 5/8	38 1/8
Carborundum	41 3/4	30 7/8	38 1/2
Cincinnati Milling Machine	44 1/2	27	40 3/8
Clevite	30 1/2	15 3/4	27 5/8
Columbia Broadcasting System	41 1/2	24 1/8	40
Consolidated Electrodynamics	47 1/2	27 7/8	35 3/4
Consolidated Electronics	44 3/4	19 1/2	36
Cornell Dubilier	24 7/8	12 3/4	22 1/4
Corning Glass	102 1/2	74 5/8	95 1/2
Curtiss-Wright	31 1/2	20 5/8	29 7/8
Cutler-Hammer	69 3/4	40 1/2	66 3/4
Daystrom	39 3/4	30	35 1/2
Douglas Aircraft	74 7/8	52	51 3/4
Eastman Kodak	154	97 1/8	141
Eaton Mfg.	64 1/2	38 1/2	61 1/4
Electric Auto Lite	39 1/4	25	38
Elgin Watch	11 5/8	6 3/4	10 1/2
Emerson Electric	56 1/2	29	51
Food Machinery & Chemical	46 1/4	35 1/4	41 1/2
Gamewell	39 1/4	20 1/2	36 5/8
Garrett	45 1/2	27	38 3/4
General Controls	29 5/8	14	27 3/4
General Dynamics	67 3/8	53	59 5/8
General Electric	60 1/4	57	78
General Instrument	22 3/8	4 5/8	18
General Mills	98	60 1/4	94 1/2
General Precision Equipment	41	27	33 7/8
General Railway Signal	39	21 1/8	38
General Telephone	64 5/8	40 3/8	62 1/4
General Time	59 1/2	16 5/8	52
General Tire & Rubber	53 5/8	22 1/4	52 1/4
International Business Machines	552	300	503
International Tel. & Tel.	65 3/8	29 1/4	62 5/8
ITE Circuit Breaker	42 3/8	34 3/4	39
Litton Industries	90 3/4	36 7/8	75
Lockheed Aircraft	32 1/2	28 5/8	29 3/4
Magnavox	60 1/2	30 1/4	51 3/4

Continued on page 329

FOR MORE INFORMATION ON ANY OF THE PRODUCTS REPORTED OR ADVERTISED IN THIS ISSUE, CIRCLE THE ITEM NUMBER ON THE INQUIRY CARD ON PAGE 291. IF THE CARD HAS ALREADY BEEN USED, WRITE NUMBER; DATE OF ISSUE; YOUR NAME, ADDRESS, COMPANY, PRODUCTS MANUFACTURED ON A POSTAL CARD. MAIL C/O READER SERVICE.

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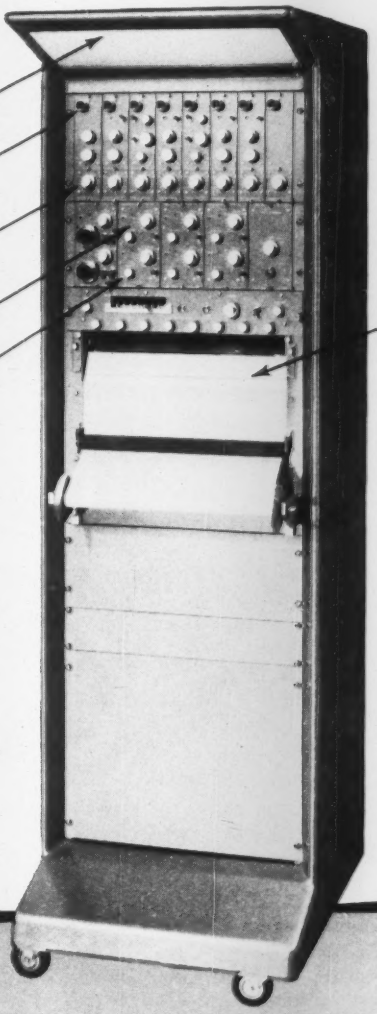
TYPE R DYNOGRAPH

the most versatile . . . most sensitive direct writing unit available



Illuminated canopy

Type 9800 series input couplers provide all input, control and balance functions. Input available both front and rear.

Type 481 Preamplifier provides sensitivities from one microvolt to 5 volts per mm.

Type 482 power amplifiers—may be used without preamplifiers for up to 10 mv/cm sensitivity

Zero suppression control

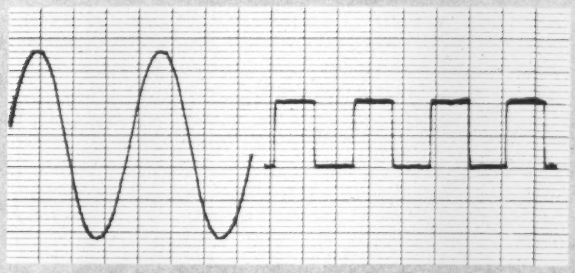
504-A paper drive—speeds from 1 to 250 mm/sec. Electrical speed shift 1 to 250 mm per minute available. Zero weave high precision drive, 850 ft. capacity (heat or electric) 1500 ft. (ink). Front loading, with full unobstructed record visible from front.

Combining all these features...

- *stable d-c sensitivity of one microvolt per mm*
- *true differential input*
- *high input impedance*
- *response to beyond 150 cps.*
- *reluctance, differential transformer, strain gage with a-c or d-c excitation, thermocouples, etc., used with all preamplifiers*
- *deflection time less than 1.5 milliseconds (2.5 ms with preamplifiers)*
- *fixed precision calibration*
- *instant warm-up*
- *precision source for d-c and 400 cycle excitation, self-contained*
- *zero suppression, twenty times full scale, both directions*

Thanks for your patience in awaiting deliveries of the Type R. Schedules were temporarily disrupted by the large volume of orders received for this radically new instrument. We are now in our new plant, with 300% more space, and are rapidly increasing production capacity. Deliveries will soon be on a current basis.

FULL SCALE, UNRETOUCHED CHARTS PRODUCED ON THE TYPE R DYNOGRAPH



EXTREME SENSITIVITY

10 Microvolt RMS Sine Wave **Ten Microvolt D-C Square Wave**

Four recording media. Heat or electric rectilinear—ink or electric curvilinear. Readily convertible.

All these features . . . plus 8 channels in only 35″ of rack space. Whatever your application for direct writing records . . . you should investigate the ability of the Offner Type R Dynograph to do the job *better* and more *simply*. Using transistor circuits* developed and tested for over three years in thousands of channels of Offner equipment, the Type R Dynograph has already proved its superiority in practically every respect to *any other* direct writing oscillograph. Write on your company letterhead for literature giving details and specifications.

**Patents granted and pending*

OFFNER ELECTRONICS INC.

3910 River Road, Schiller Park, Ill.
(Suburb of Chicago)

For more information circle 26 on inquiry card.

New DAYSTROM-WESTON MULTI-POINT RECORDER

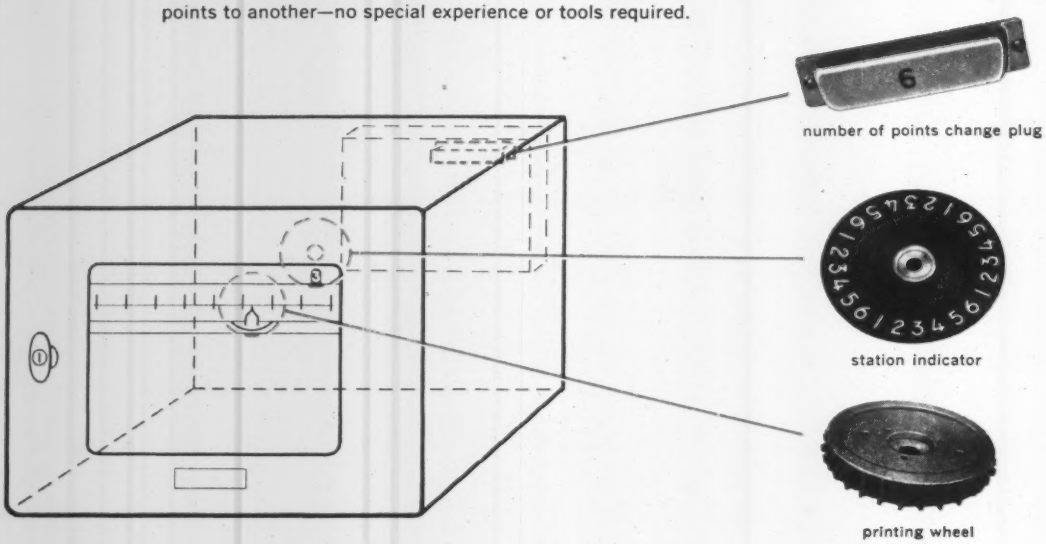
Introduces

INTERCHANGEABILITY—from one number of points to another—one range to another—one chart speed to another.

NEW LOW COST – a single instrument: handling from 2 to 24 points! A single price: 15% less than the average multi-point!

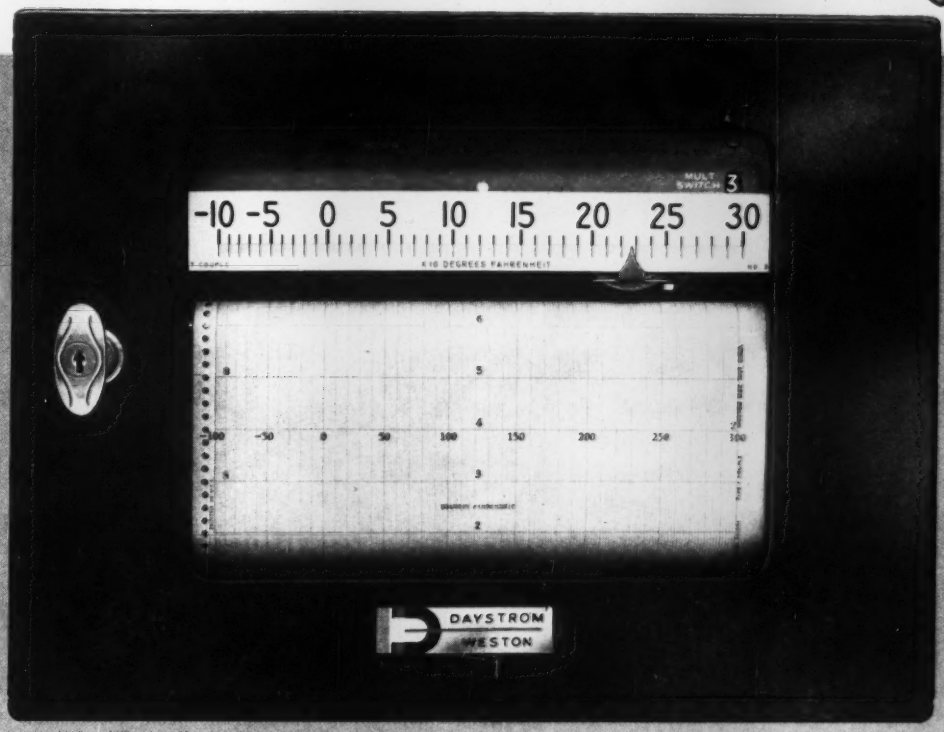
39% SMALLER CASE – with full-size chart and full ¼ of 1% accuracy.

Here is all you need to change from one number of points to another—no special experience or tools required.



For more information circle **27** on inquiry card.

WITH UNITIZED* design



*** UNITIZATION: the grouping of related components—in Daystrom-Weston Recording Potentiometers—in the simplest, most serviceable, most efficient manner.**

There's tremendous value in this remarkably small instrument—thanks to Weston's *unitized design* and *unique pricing policy*. The size is a big dividend in itself, wherever panel space is at a premium. This is the most compact multi-point recorder—using a full-size chart, and of comparable accuracy (¼%)—ever available. Specially important: a single recorder, offered at a single low price, is easily interchangeable from one number of points to another . . . from one range to another . . . from one chart speed to another! It's so versatile it makes all other multi-point recorders obsolete!

There's none of the clutter or complexity you might expect in an instrument that serves as many functions as this. There's no jungle of wires to hamper inspection and maintenance. Every part is engineered for simplicity—which means trouble-free operation over the years. Components are kept to a minimum, and integrated into compact, rugged panels. Parts are actually more accessible than in much larger instruments.

The new Weston potentiometer recorder accommodates 2, 3, 4, 6, 8, 12, 16 or 24 signals. Changes in the number of recorded points can be made quickly and easily when desired. The unique etched circuit switch is geared directly to the printing head . . . can't get out of synchronization. And this recorder has all of the features that distinguish the other fine instruments in the Weston potentiometer line: simplified range changing with exclusive universal standards . . . high resistance to shock, vibration and corrosion . . . lowest spare parts inventory due to interchangeability of parts.

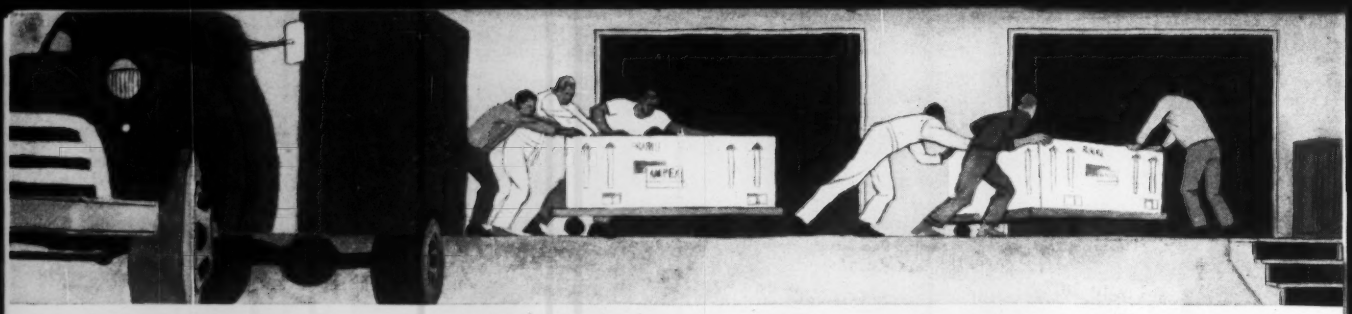
For more complete information on the Daystrom-Weston *multi-point potentiometer recorder* . . . the *single-point recorder* . . . or the *recorder-controller* . . . call your local Weston representative, or write to Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. *In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 10, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.*

DAYSTROM-WESTON

Industrial Instruments

A DAYSTROM UNIT

For more information circle **27** on inquiry card.



Perfect complement to your AMPEX system

. . . your AMPEX Field Service Engineer

Ampex service begins the moment your new equipment comes out of the cases. Whether it is a single FR-100A or a complete digital tape handling system, your Ampex Service Engineer is there on installation day.

He sees to the proper installation of your equipment. He tests it with its original factory checkout tape and specially designed calibration units. And he thoroughly instructs your staff in its operation.

Throughout your warranty period—and afterwards—Ampex Field Service is instantly available for modifications or *fast* replacements, avoiding costly down time.

Minutes after your call to the nearest of 12 offices or to the Ampex Home Office, extra parts or components are on their way. And this same close tie between factory and Field Service keeps Ampex Service Engineers constantly up-to-date on the latest techniques and equipment.

Available are Field Service programs ranging from scheduled preventive maintenance calls or time and materials contracts, to the services of a full-time resident Ampex engineer. With your purchase, an Ampex data specialist will discuss a service and spare-parts plan tailor-made to suit your magnetic tape instrumentation needs.

First in magnetic tape instrumentation

AMPEX CORPORATION

AMPEX INSTRUMENTATION DIVISION
934 Charter Street, Redwood City, California
Offices in USA and Canada. Engineering representatives cover the world.

For more information circle **28** on inquiry card.

New York Stock Exchange:

Continued from page 324

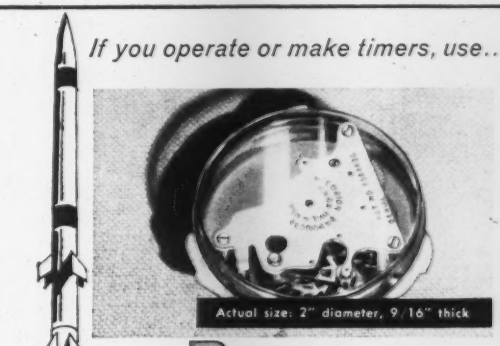
Minneapolis-Honeywell	126	76	117
Mallory	42	23 5/8	38
Minnesota Mining & Mfg.	122	73 1/2	121
Motorola	62 3/4	35	60 1/2
National Acme	59 1/2	43 7/8	55
National Cash Register	86 1/4	50 1/2	73 1/4
North American Aviation	45 7/8	25 5/8	41 1/8
Northrop Aircraft	37 1/2	22 1/8	34
Otis Elevator	75 1/4	40 1/4	66 1/2
Philco Corp.	26 3/8	12 3/8	23 3/4
Radio Corp. of America	50 1/8	30 1/4	47 1/8
Raytheon Mfg.	69	21 1/2	60
Reliance Electric	50 1/4	31	45 1/2
Rheem Mfg.	21 1/8	10 1/2	20 3/4
Robertshaw-Fulton	35 1/4	22 1/4	34 7/8
Royal McBee	25 1/4	16	23 5/8
Sangamo Electric	49 1/4	25	43 3/4
Siegler Corp.	35 1/8	12 3/4	34 3/8
Sperry Rand	25 3/8	17 1/4	22 1/8
Square D	33 1/4	20 1/8	30 3/8
Standard Coil Products	19 1/4	6	18 1/4
Starrett (L.S.)	74 3/4	57	70 1/2
Stewart-Warner	46 3/4	29	43 3/8
Sylvania Electric	63 1/2	31 1/2	61 3/8
Telautograph	10 7/8	3 3/4	9 1/4
Texas Instruments	86	26 3/4	71 7/8
Thompson-Ramo Wooldridge	73	41 3/8	57 1/2
Tung-Sol Electric	52 1/4	23 1/4	43 3/8
Underwood Corp.	27 1/4	12 7/8	25 5/8
Union Carbide Corp.	127 1/4	83 7/8	123
United Shoe Machinery	49 7/8	32	49
Western Union	35 3/8	15	34 5/8
Westinghouse Air Brake	35 1/2	17 7/8	33 1/2
Westinghouse Electric	76 1/4	55 1/2	74 1/4
Worthington Corp.	78 1/4	45 1/4	78 1/4

Over-The-Counter

QUOTATIONS AS OF FEBRUARY 16, 1959

	BID	ASKED
Aerovox Corp.	7	7 3/4
Aircraft Radio Corp.	30	30 3/4
Argus Corp.	37 3/4	38 1/4
Bittel-McCullough	30 1/2	32
Electronics Associates	48	50 1/2
Erie Resistor Corp.	10	10 5/8
Fisher Governor Company	17 7/8	18 5/8
Foxboro Company	49	51
G. M. Giannini	27 3/4	29
Industro Transistor	2 3/4	3 1/4
Liquidometer Corp.	6 1/2	7 1/4
W.L.Maxson	12 7/8	14
Penn Controls	-	21
Speer Carbon, Inc.	50 3/4	52
Sprague Electric	39 1/2	41
Taylor Instruments	32 1/2	33 1/2
Telecomputing Corp.	8 1/4	8 7/8
Topp Industries	13 1/4	13 7/8
Varian Associates	41 1/2	42 3/4
Vitro Corp. of America	15 5/8	16 1/4

If you operate or make timers, use...



PRECISION ESCAPEMENTS

Compact PRECISION timing governors (escapements) are especially applicable to installations where space is limited.

Over 800,000 PRECISION built governors are in daily use all over the country in timing devices of many kinds.

Find out about these units or our capacity to make a special one for you.

Write for literature or send us specifications for the governor you need.

PRECISION PRODUCTS, INC.

DESIGNERS AND MANUFACTURERS OF MECHANICAL TIMERS • INSTRUMENTS • PRECISION PARTS AND ASSEMBLIES

DEPT. IA-3 • 530 SOUTH QUAKER • TULSA 20, OKLAHOMA

For more information circle **29** on inquiry card.

CARL ZEISS

WEST GERMANY

LIGHT SECTION MICROSCOPE

This microscope produces a profile of the surface being examined by the well known light-section method. Roughness depth, as well as groove distances of machine-finished surfaces, can be measured. Internal surfaces can be examined by making lacquer replicas.

The newly developed revolving nose-piece for the objectives makes it possible to quickly change the magnification (height of profile) between 400x and 200x. At 400x, depths of roughness of 40 to 160 micro inches can be measured; at 200x, those of 120 to 4,000 micro inches.

Photographs for comparison and control purposes can be taken by mounting a 35mm miniature camera at top of the instrument.

In addition to the stage plate of the stand, a mechanical stage and center cradle (for turned parts) are available.

Write for detailed literature.

CARL ZEISS, INC.

485 FIFTH AVENUE, NEW YORK 17, N. Y.

GUARANTEED UNINTERRUPTED REPAIR SERVICE

For more information circle **30** on inquiry card.

briefs

Thermocouple Tables

A new, compact chart of Temperature-Millivolt Conversion Tables . . . makes it possible to convert either Fahrenheit or Centigrade temperatures, in 5 degree

ABBREVIATIONS USED IN TABLES	ISA SYMBOL	CONDUCTORS POLARITY POSITIVE (+)	NEGATIVE (—)	CONVERSION FACTOR TO 0°C REFERENCE JUNCTION*
$^{I-C}_{J}$	J	IRON	CONSTANTAN	+1.28 MILLIVOLTS
$^{I-C}_{Y}$	Y	IRON	CONSTANTAN	+1.32 MILLIVOLTS
$^{C-A}_{K}$	K	CHROMEL	ALUMEL	+1.00 MILLIVOLTS
$^{C-C}_{T}$	T	COPPER	CONSTANTAN	+0.99 MILLIVOLTS
$^{CR-C}_{E}$	E*	CHROMEL	CONSTANTAN	+1.50 MILLIVOLTS
$^{P10}_{S}$	S	PLATINUM	PLAT. 10% RH	+0.143 MILLIVOLTS
$^{P13}_{R}$	R	PLATINUM	PLAT. 13% RH	+0.142 MILLIVOLTS
P30	P30*	PLAT. 30% RH	PLAT. 6% RH	+0.007 MILLIVOLTS

*Thermo Electric Symbol

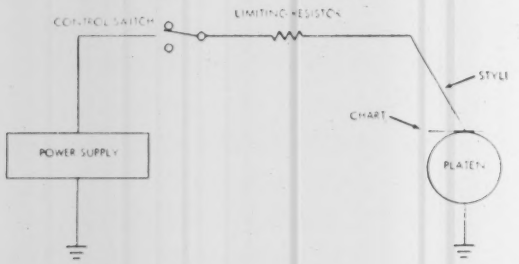
*Conversion factors to 32° F Reference Junction on reverse side

increments, to millivolt values for eight different thermocouple calibrations . . . folds in half to 8-½" x 11" size and is punched for use in a three-ring binder . . . may also be used as a wall chart . . . (*From new 4-page chart, Thermo Electric Co., Inc., Saddle Brook, N. J.*)

For this literature circle **174** on inquiry card.

Multistylus Recorder

The Radicorder employs an electrosensitive chart which has a sulphate surface coating. Passage of an electrical current through this coating, from the styli to the platen, results in black trace-marks. Thus, Radi-



corder provides direct writing without processing and without pens, light sources, or inks. Consequently, it can be used in any position under a wide range of extreme environmental conditions.

This instantaneous electric writing technique provides a direct, immediate printout. Employed as an editing building-block in a data acquisition or processing system, the resultant Quick-Look feature eliminates the necessity of electronically translating complete data and thereby reduces computer workloads . . . (*From new 8-page Bulletin A-100, Radiation, Inc., P. O. Box 37, Melbourne, Fla.*)

For this literature circle **175** on inquiry card.

Temperature Scanner/Logger

The Temperature Indicator Monitor (TIM) is an accurate instrument which functions to scan and monitor from a quantity of thermocouple inputs . . .

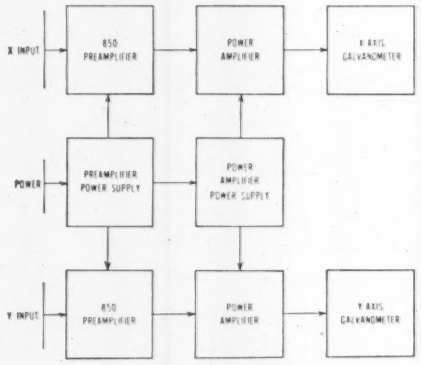
Each variable is fed through a relay to an especially designed chopper amplifier. The requirements for amplification are more complex in a scanning system than in other areas of instrumentation. The first parameter, that of a short sampling interval for each input, requires excellent frequency response of the amplifier. A second parameter of major significance is, that while an amplifier of good frequency response can be produced, it axiomatically passes undesirable noise such as 60 cycle ripple and high frequency transients which cause false alarm indication.

The Kybernetes amplifier, which can best be described as a self-balancing all-electronic unit, meets these requirements. Its unusual feature is that its frequency response diminishes as it approaches the null state. Its inherent rejection of 60 cycle noise, without the incorporation of filtering circuits, is 200 to 1. Long term drift is less than 30 microvolts and noise is less than 5 microvolts. Additionally all inputs to the amplifier are isolated in such manner that the system is not suspectible to ground loops of any type . . . (*From new 4 page Bulletin MSP-155, Kybernetes, Div. of Hagan Chemicals & Controls, Inc., P. O. Box 1346, Pittsburgh 30, Pa.*)

For this literature circle **176** on inquiry card.

X-Y Recorder

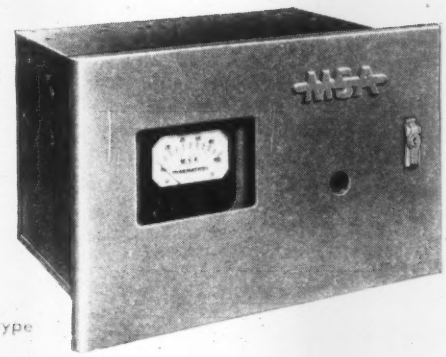
A 100-watt super pressure mercury arc lamp produces a light beam which passes through a fixed aperture to a spherical mirror on the X-axis galvanometer (a). It is then reflected to a flat narrow mirror on the Y-axis galvanometer (b) to a fixed flat mirror



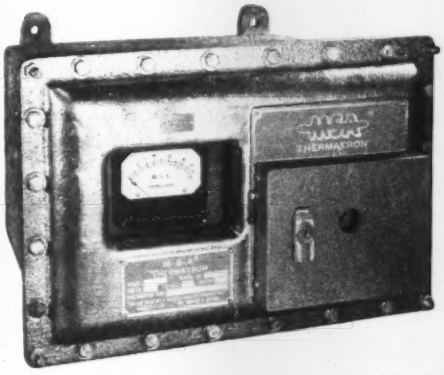
which redirects the light beam to the recording chart.

The light beam may be cut off momentarily by a 3-position switch which controls a shutter. This shutter may also be operated remotely. A second control provides several field stops to increase or decrease light intensity. Lamp current is also adjustable and is indicated by a front panel meter . . . (*From new 8-page issue "The Right Angle," Vol. 6/No. 2, Sanborn Co., Industrial Div., 175 Wyman St., Waltham 54, Mass.*)

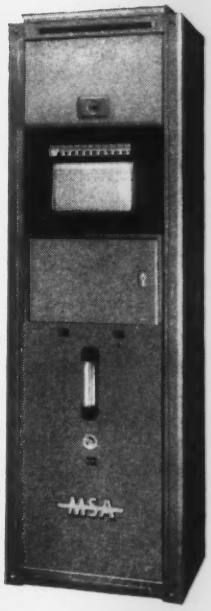
For this literature circle **177** on inquiry card.



Non-explosion-proof type

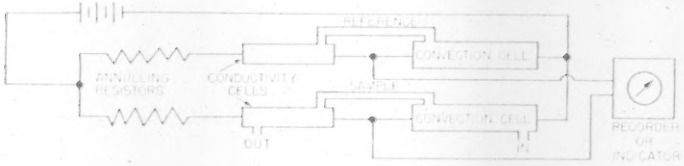


Explosion-proof type



M-S-A Gas Thermatron with recorder mounted in cubicle

M-S-A® Gas Thermatron continuously analyzes for one component in multi-component gas mixtures



Schematic Flow and Wiring Diagram

This unique development in gas analysis instrumentation combines thermal convection and thermal conductivity effects to provide selective measurement of a single component of a mixture without "scrubbing out" interfering components.

MSA has been applying its knowledge of gas analysis to specific customer problems for over 30 years. Latest and most unique solution to some of these problems is the M-S-A Gas Thermatron.

This unit selectively analyzes for one component of at least a ternary mixture of gases (without removal of any component) by employing both thermal conductivity and thermal convection properties of the gas.

Other standout features: Calibration is possible over very narrow or very wide ranges (0-100% Gas). Construction is rugged. Operation is stable. Maintenance is simple, infrequent. High accuracy and speed of response are inherent characteristics.

In process control, you can use the selective M-S-A Thermatron for analysis of components in hydrogenation, ammonia synthesis, hydrocarbon synthesis and other processes.

In the area of atmosphere/combustion control, you can analyze for CO_2 or H_2 in atmospheres containing H_2, CO_2, N_2, CO and water vapor. Or, for CO_2 in flue gases.

And where gas purity is a factor, the M-S-A Thermatron is helpful in the analysis of argon, hydrogen, helium or water vapor in oxygen, air or nitrogen.

The MSA Instrument Specialist will welcome an opportunity to relate these advantages to your specific operation. Contact him soon. And write us for informative new bulletin on this inexpensive thermal conductivity analyzer.

INSTRUMENT DIVISION
Mine Safety Appliances Company
Pittsburgh 8, Pennsylvania

For more information circle **31** on inquiry card.

SCIENTIST MEETS
ACRAGAGE®
RESULT: PROGRESS!

DEPENDABILITY KEYNOTES THIS TEAM WORKING TO MAKE BETTER PRODUCTS FOR MORE PEOPLE!

The above scientist engaged in research for a leading petroleum producer is typical of thousands in many different industries who rely on Acragage for dependable, accurate instrumentation. This reliance is based on Acragage's reputation for precision workmanship and quality features. The photo shows one of these outstanding features: the full area rear blowout disc. This disc, along with the solid front safety case, assures absolute protection to the viewer: any buildup of internal pressure blows the disc to the rear . . . away from the viewer. Other features include a longer Bourdon Tube, precision movements, and a choice of Tube materials. Write for more information and catalog!

ACRAGAGE GIVES YOU MORE GAGE PER DOLLAR

- VACUUM GAGES
- PRESSURE GAGES
- COMPOUND GAGES
- TEST GAGES
- ELECTRIC TRANSMITTER GAGES
- RECEIVER GAGES
- PNEUMATIC TRANSMITTER GAGES
- CHEMICAL PROTECTORS

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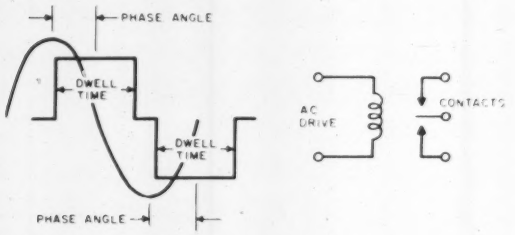
Title_____
Firm_____
Address_____
City_____ Zone____ State_____

For more information circle **32** on inquiry card.

The Contact Modulator

The name chopper is derived from the contact devices used to tone-modulate CW when CW first replaced spark transmission . . . a chopper is best defined as being driven by a sine wave and delivering a modified square wave. Contact modulators are



unique in one special respect, their ability to switch between a very low resistance of much less than 0.1 ohm to over 10,000 megohms, and in very short time intervals.

If high input impedance and good null stability are required of a DC amplifier, a chopper may be the only practical solution. At impedances of around 1,000 ohms, and with not too much of a drift problem, diode or transistor modulators can be used readily. In general, if good zero stability is needed with nulls less than about 25 microvolts, and impedances over a few hundred ohms, a chopper is almost imperative . . . (*From new 24-page Booklet "Why Use Choppers?", Airpax Products Co., Seminole Div., Fort Lauderdale, Fla.*)

For this literature circle **178** on inquiry card.

PVC Valves

Hancock PVC Valves will fulfill a wide range of applications, particularly in the handling of acids and alkalis. An application Table is included (A = Excellent; B = good; X = unsuited).

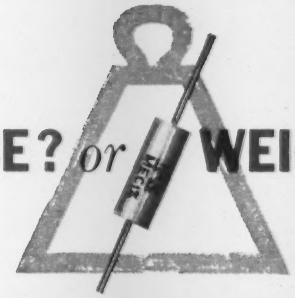
Unplasticized PVC, in contract to PVC blended with other organics, is noted for its greater strength

REAGENT	72°	140°	REAGENT	72°	140°
Benzene	X	X	Chromium Plating Solutions	A	B
Benzoic Acid	A	B	Citric Acid	A	A
Black Liquor	A	A	Copper Chloride	A	A
Bleach 12.5% Active Cl_2	A	A	Copper Cyanide	A	A
Borax	A	A	Copper Nitrate	A	A
Boric Acid	A	A	Copper Plating Solutions	A	A
Brass And Bronze Plating Solutions	A	A	Copper Sulfate	A	A
Bromic Acid	A	A	Cleaning Solutions, Alkaline & Acid	A	A
Bromine, Liquid	X	X	Cottonseed Oil	A	A
Bromine, Water	A	A	Cresylic Acid, 50%	A	A
Butadiene	A	A	Crude Oil, Sour	A	A
Butane	A	A	Detergents, All Types	A	A
Butanol, Primary	A	A	Dextrin	A	A
Butanol, Secondary	A	X	Dextrose	A	A

as well as resistance to chemical deterioration and high creep. Non-toxic, PVC can not affect the purity of foods and fluids being processed . . .

Although light in weight and easy to handle, the strength-to-weight ratio of PVC rates among the highest of all construction material . . . Non-sparking, non-flammable, and self-extinguishing, PVC guarantees greater safety from fire and explosion even when used with volatile materials. In addition, it has excellent electrical and insulating characteristics . . . (*From new 4-page Bulletin 290, Manning, Maxwell & Moore, Inc., Watertown, Mass.*)

For this literature circle **179** on inquiry card.

concerned about **SPACE? or**  **WEIGHT?**

USE NEW IRC MOLDED METAL FILM PRECISION RESISTORS

If you need the precision of a wire wound resistor, but in a space-saving, weight-saving size, IRC's new Type ME Metal Film Precision Resistors are for you.

Not only do they save weight and space but they are equal or superior to wire wound resistors in many respects as noted at right:

1. Higher environmental performance
2. Higher statistical performance on environmental tests
3. Higher ambients, extended lifes, extended moisture and temperature cycling
4. Better RF characteristics
5. Comparable or lower in cost
6. Resistance values are stable—just as stable for a 1% resistor as for a 0.10% resistor—just as stable for low T.C.'s as high T.C.'s.

TEMPERATURE COEFFICIENT—In order to meet the variety of T.C. requirements, precision metal films are offered in eight classifications. You may order T.C.'s as close as those for precision wire wounds... or, where it is not critical, T.C.'s up to ±100 PPM are available. Classifications are listed below:

Classification	PPM	Temperature span
T-1	±100	−55°C +165°C
T-2	±50	−55°C +165°C
T-3*	−0 +100	−55°C +165°C
T-4*	+0 −100	−55°C +165°C
T-5	±25	+25°C +105°C
T-6*	+50 −0	−55°C +165°C
T-7*	−50 +0	−55°C +165°C
T-8*	±25	−55°C +165°C

*Special types.

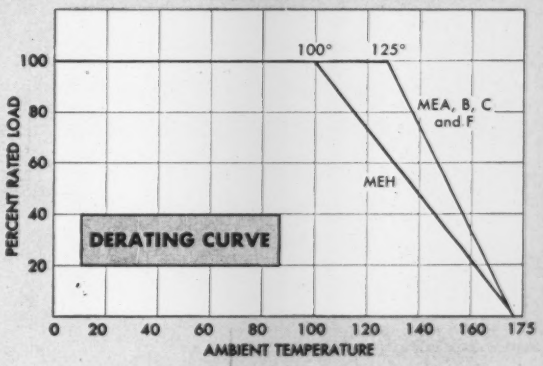
OTHER CONSTRUCTION ADVANTAGES—The new IRC Molded Metal Film Resistors eliminate two other bugaboos of wire wound resistors.

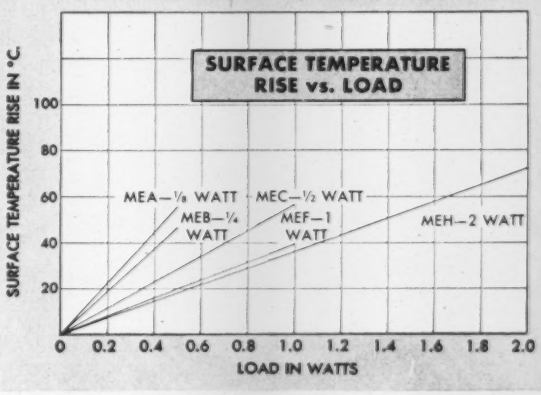
1. No cold joint problem. There is no unsolderable resistance wire in the metal film resistor to be soldered to the terminals. 2. No failure due to excess winding stresses because there are no windings.

IRC Type	5 Wattage Ratings (125°C Ambient)	Maximum Continuous Voltage Rating	New Range Minimum** Ohms	New Range Maximum** Ohms
MEA	⅛	250 V	30	500 K
MEB	¼	300 V	50	1 meg
MEC	½	350 V	50	1.5 meg
MEF	1	500 V	50	4 meg
MEH	2*	750 V	100	10 meg

*100°C Ambient Max. below 500 K ohms.

**NEW EXTENDED RANGES—These new ranges have lower minima and higher maxima by far than our former corresponding values.





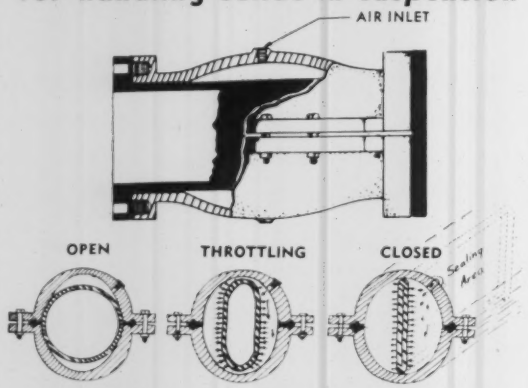
Write for New Catalog Data Bulletin — IRC

INTERNATIONAL RESISTANCE COMPANY • Dept. 451 • 401 N. Broad St., Phila. 8, Pa. • *In Canada:* International Resistance Co. Ltd., Toronto, Licensee

For more information circle **33** on inquiry card.

RED JACKET VALVE

for handling solids in suspension



1. Only one wearing part, the rubber sleeve
2. Unobstructed streamline flow characteristics
3. Sleeve forms around entrapped material for positive seal
4. Valve has built in operator

send for catalog

RED JACKET COMPANY, INC.

500 Bell Avenue Carnegie, Penna.

For more information circle **34** on inquiry card.

PHILADELPHIA

THERMAL CONTROLS AND THERMOMETERS

Specify!
THE BEST!
A half century of experience is back of every instrument we make. You get assured accuracy and long dependable performance when you specify "Philadelphia." Our specialized staff will be glad to discuss your problem in our field.
SEND FOR CATALOG
110

Since 1905

PHILADELPHIA THERMOMETER CO.

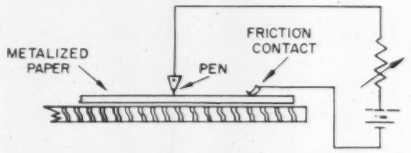
4401 N. Sixth St. • Philadelphia 40, Pa.

For more information circle **35** on inquiry card.

BRIEFS—CONTINUED

Inkless Recording

The inkless system consists of a zinc-coated chart paper, a metal stylus and a power supply connected in a series . . . Zinc is burnt away at the tip of the stylus. The trace thickness is adjustable by a control

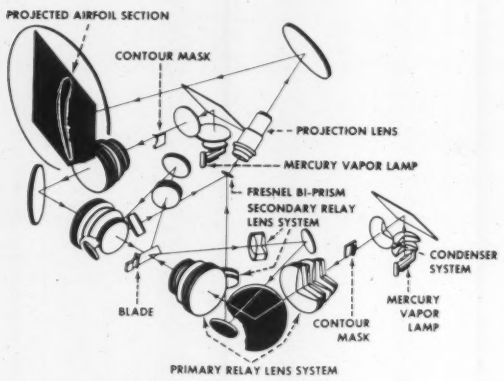


located above the scale. Since the trace is transparent, a copy of the recording can be made on blueprint equipment or photocopy machines such as the Verifax. A self-contained low-voltage power supply provides approximately 10 ma dc for the pen. On spring-wound recorders, battery power can be substituted.—(*From new 12-page Recorder Catalog, Curtiss-Wright Corp., Electronics Div., Carlstadt, N. J.*)

For this literature circle **180** on inquiry card.

Section-Profile Projector

Briefly, the Projector is based on the idea of illuminating an airfoil section to produce a line of light . . . at a specified position on the blade. The line of light, covering the complete profile of the blade, is projected at magnification upon the viewing screen to show the contour of the section . . . Heretofore,



three principal difficulties were encountered in other systems of this type—insufficient illumination to produce a well-defined image, limitations on the length of blade that could be inspected, and inability to project sections of shrouded blades or blades with high twist.

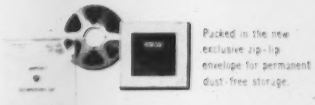
Identical optical systems are used on both sides of the blade, the entire profile of a section being projected by matching the half-profiles from each system . . . (*From new 4-page Bulletin "The Kodak Section-Profile Projector," Eastman Kodak Co., Apparatus and Optical Div, Rochester 4, N. Y.*)

For this literature circle **181** on inquiry card.

5,000,000 DATA BITS...AND YOU CAN'T LOSE ONE!

5,000,000 data bits or more are recorded on a reel of tape used in digital recording! Your data processing operations depend on the flawless recording *of every single bit*. This kind of performance calls for a high degree of specialization in the tape itself, a tape designed specifically for this use...

SOUNDCRAFT TYPE A TAPE FOR DIGITAL RECORDING — Only SOUNDCRAFT with the world's newest, most modern tape manufacturing facilities, has engineered all the critical properties required for digital recording into a single tape. The result: on transport after transport SOUNDCRAFT Type A Tape out-performs and outwears all competitors by as much as 7 to 1. Why risk costly errors? Use error-free SOUNDCRAFT Type A Tape for Digital Recording. Write for SOUNDCRAFT Type A Tape Brochure.



REEVES SOUNDCRAFT CORP.

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For more information circle **36** on inquiry card.

He's getting results...

WITH THE NEW BRUSH RECORDER MARK II

So can you. The versatile Mark II is an integrated oscillograph package—a readout tool for engineers and technicians everywhere . . . in the shop . . . in the lab . . . or in the field.

Just plug it in . . . put it to writing . . . anywhere.

PERFORMANCE SPECIFICATIONS

Recordings—Uniform, crisp, easily reproduced. Trouble-free ink writing on precision chart paper.

Channels—Two analog, plus two event markers.

Sensitivity—Maximum of 10 mv/chart line (mm); range, 10 mv to 400 v.

Input—Differential; impedance 5 megs each side to ground.

Frequency Response—D.C. to 100 cps.

Write for free booklet 2521A for complete specifications. Immediately available from stock. Price $1350.

brush INSTRUMENTS
DIVISION OF
37TH AND PERKINS **CLEVITE** CORPORATION CLEVELAND 14, OHIO

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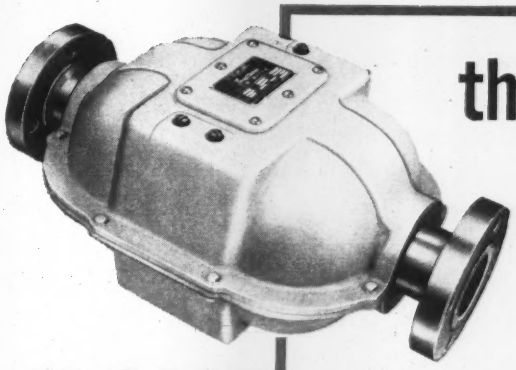

the meter with NO flow restrictions

now handling all these difficult liquids

Foxboro's first Magnetic Flow Meter went "on stream" in 1954. Today, this new-type meter has gained industry-wide application for precise, linear measurement of corrosive, viscous and other difficult process liquids.

The Magnetic Flow Meter is installed as simply as a length of pipe, with no straight runs required. It connects by standard electric cable to remote Foxboro Dynalog* Electronic Recorder. Overall accuracy of the system is ±1%. And the meter even measures reversing flows.

With easy-to-measure liquids, or with tough ones like those listed below, the performance-proved Foxboro Magnetic Flow Meter provides flow measurement with no line restrictions. For complete details, write today for Bulletin 20-14C. **The Foxboro Company, 463 Neponset Ave., Foxboro, Mass.**

*Reg. U.S. Pat. Off.

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hydrochloric acid
ammonium nitrate solution
phosphate slurry
rayon viscose
magnesium carbonate slurry
phosphoric acid
detergent concentrate
rosin size
starch solution
rubber copolymer
liquid latex
sulphuric acid
70% sodium hydroxide
soap flow
styrol
magnesium hydrate

FOOD

beer
grape juice
apple juice
pineapple juice
tomato juice
milk
starch slurry
sugar syrup
coffee slurry
molasses

PULP AND PAPER

all types of pulp stock
cooking liquors
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bleaching chemicals
lime mud slurries
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activated sludge
fresh water
raw sewage
digested sludge
primary sludge
return activated sludge

METALS AND MINING

pickling acid
sand slurry
ferrous chloride
limestone shale slurry
bauxite slurry
gilsonite slurry
aluminate liquor
uranium ore slurry
thickener mud
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flue dust slurry
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drilling mud
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scrubber recycle water
urea solution
nitrate solution
spent acid
sodium silicate & water
sodium chloride brine
tar-sand slurry

METER SIZES RANGE FROM ¾ INCH TO OVER 6 FEET PIPE DIAMETER

FOXBORO REG. U.S. PAT. OFF. **MAGNETIC FLOW METERS**

For more information circle **38** on inquiry card.

In this brochure—complete facts on DIALCO's

DATALITES®

For the Computer-Automation Industries

DATALITES by DIALCO are ultra-miniature Indicator Lights specially designed to meet the critical requirements of the computer-automation fields. Made in 2 basic styles: *Lamp Holders with* DIALCO'S own *replaceable Lamp Cartridges* (see above); or integrated DATALITES *with Built-in Neon Lamps* which are *not replaceable* (see below). Ultra-compact, single units mount in ⅜" clearance hole; the twin-lamp assembly mounts in ¾" clearance hole.

LAMPS USED:
T-1¾ wire-lead incandescent lamps, or NE-2E neon lamps, in aluminum sleeves capped with plastic lenses (7 colors).
With Rotatable Lenses
181
161
No. 249-7840-1431
DATALITES with Built-in NE-2E Neon Lamps
No. 249-7841-931 with built-in resistor
No. 250-7840-1431
No. 250-7841-1431 with built-in resistor
(Illust. approx. actual size)

DATALITES have fully insulated terminals and conform to all applicable military specifications. Integrated units are available *with or without built-in resistors.* The cylindrical lenses can be hot-stamped with digits, letters, etc. Complete details in *Brochure L-160.* Send for it now.

SAMPLES ON REQUEST—AT ONCE—NO CHARGE

Foremost Manufacturer of Pilot Lights

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For more information circle **39** on inquiry card.

The Modern Road to Success

We are in constant touch with leading business organizations in all lines. Through an investigation of thousands of such concerns, we have found how they operate and how they solve their problems.

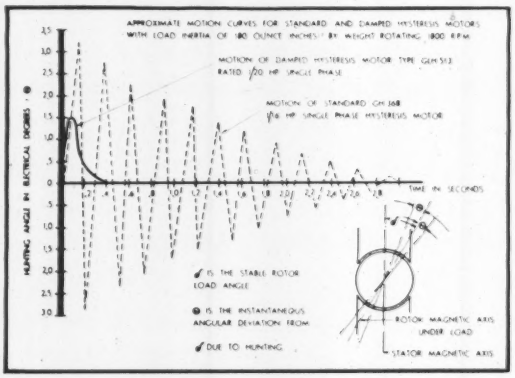
After this information has been collected and boiled down to essentials, elements common to the experience of the majority of successful firms are tabulated. In this manner, the Modern Business Course and Service does what no one man could do for himself in anywhere near a comparable period. It offers the opportunity to learn the latest methods and procedures of companies actively engaged in business today.

It figuratively takes you into the offices of sales managers, and lets you watch them work while they tell you about the methods they use to get results . . . (*From new* 48-*page Booklet "Forging Ahead in Business,"—Alexander Hamilton Institute Inc.,* 71 *West* 23 *St., New York* 10, *N. Y.*)

For this literature circle **182** on inquiry card.

Polarized Hysteresis Motors

The purpose of these units is to overcome the disadvantage of the hysteresis motor, in its feature to lock in at any infinite number of positions, compared to the reluctance motor's ability to lock in or phase in definite positions . . . Earlier designs of hysteresis motors, with their soft rotor couplings and low synchronous torques, showed little tendency to hunt. As design


APPROXIMATE MOTION CURVES FOR STANDARD AND DAMPED HYSTERESIS MOTORS WITH LOAD INERTIA OF 180 OUNCE INCHES² BY WEIGHT ROTATING 1800 R.P.M.
MOTION OF DAMPED HYSTERESIS MOTOR TYPE GEM 513 RATED 1/20 HP SINGLE PHASE
MOTION OF STANDARD GH 168 1/16 HP SINGLE PHASE HYSTERESIS MOTOR
HUNTING ANGLE IN ELECTRICAL DEGREES - θ
TIME IN SECONDS
θ IS THE STABLE ROTOR LOAD ANGLE
Φ IS THE INSTANTANEOUS ANGULAR DEVIATION FROM θ DUE TO HUNTING
ROTOR MAGNETIC AXIS UNDER LOAD
STATOR MAGNETIC AXIS

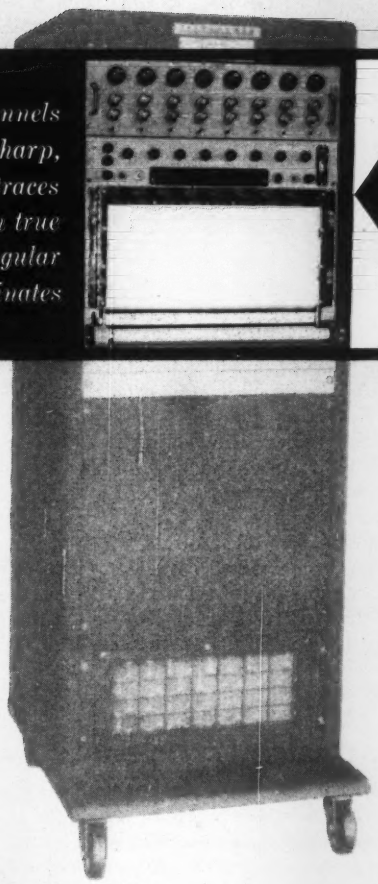
techniques were improved . . . difficulties with hunting became proportionately greater. The curve shows the comparison between a standard 1/16 HP hysteresis motor and the newer non-hunting unit. It may be seen that the non-hunting motor not only radically reduces the duration of any oscillation but cuts the magnitude of the initial swing about 50% . . . The standard motor is capable of damping out after one oscillation a connected load inertia of approximately 9 oz. in.² by weight, as against a value of 180 oz. in.² for the motor with damping motion . . . (*From new* 32-*page Catalog* 4*C, Electric Indicator Co. Inc., Camp Ave., Stamford, Conn.*

For this literature circle **183** on inquiry card.

ALL THIS

- LINEARITY 0.5% OF FULL-SCALE
- COMPLETELY TRANSISTORIZED
- CURRENT FEEDBACK AMPLIFIERS
- VELOCITY FEEDBACK DAMPING
- GAIN STABILITY BETTER THAN 1%
- 9 ELECTRICALLY CONTROLLED CHART SPEEDS

6 or 8 channels of sharp, inkless traces in true rectangular coordinates



8-Channel Model 358-5480 Oscillographic Recording System . . . 6-Channel Model 356-5480 also available.

in a new, simplified . . .

5-VOLT FULL-SCALE SANBORN RECORDING SYSTEM

This new Sanborn direct writing system provides six or eight channels for computer readout, telemetry recording, DC voltage monitoring and similar applications where 0.1 volt/div sensitivity is sufficient and no preamplification is needed. The input impedance is 100,000 ohms. Frequency response is 3 db down at 100 cps at 10 div peak-to-peak amplitude; hysteresis is less than ±0.1 div. A 17½″ Recorder-Amplifier-Power Supply package displays 8″ of chart, locks in or out, loads easily from the front, has a built-in footage indicator and take-up, and can be completely remote-controlled. Galvanometers are rugged, low impedance, low voltage units with enclosed construction. The 5¼″ Control Panel provides front and rear inputs, attenuator ratios of 1, 2, 5, 20 and 50, internal 2-volt calibration signals, position and smooth gain controls. The system is available in either the 60″ mobile cabinet as shown (complete with power panel, wiring harness and built-in blower) — or as separate Recorder-Amplifier-Power Supply and Control Panel units for rack mounting.

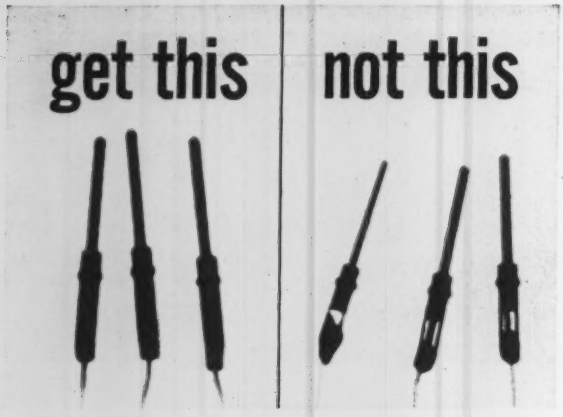
Find out what this new system can do for *you*. Ask your local Sanborn Industrial Sales-Engineering Representative for complete facts — or write the Industrial Division in Waltham.

See this new System at the I.R.E. Show — Booths 3601-03-05

SANBORN COMPANY

175 Wyman Street, Waltham 54, Mass.

For more information circle 40 on inquiry card.



Actual X-ray Photos Show How IDEAL Thermo-Tip Resistance Soldering Tools Reduce Costly Voids in Winchester and Cannon Plug Pins

Because the whole pin is heated, "cold-flow joints" are eliminated; failures are greatly reduced

Pin No.	Conduction Method: Length of void	Conduction Method: % of void	Resistance Method: Length of void	Resistance Method: % of void
1	0.12″	40	0.00″	0
2	0.12″	40	0.00″	0
3	0.07″	23	0.05″	17
4	0.18″	60	0.00″	0
5	0.06″	20	0.06″	20
6	0.05″	17	0.04″	13
7	0.02″	7	0.05″	17
8	0.08″	27	0.01″	3
9	0.09″	30	0.07″	23
10	0.12″	40	0.09″	30
11	0.15″	50	0.04″	13
12	0.12″	40	0.06″	20
13	0.09″	30	0.01″	3
14	0.12″	40	0.08″	27
15	0.11″	37	0.02″	7
16	0.10″	33	0.04″	13
17	0.07″	23	0.04″	13
18	0.09″	30	0.09″	30
19	0.11″	37	0.10″	33
20	0.11″	37	0.06″	20
21	0.05″	17	0.01″	3
22	0.15″	50	0.00″	0
23	0.11″	37	0.05″	17
24			0.07″	23

● These production test results from a major Aircraft manufacturer prove the superiority of Ideal Resistance Soldering Tools to the best available commercial soldering irons. Voids averaged 33% with soldering irons. With resistance soldering only 14%.

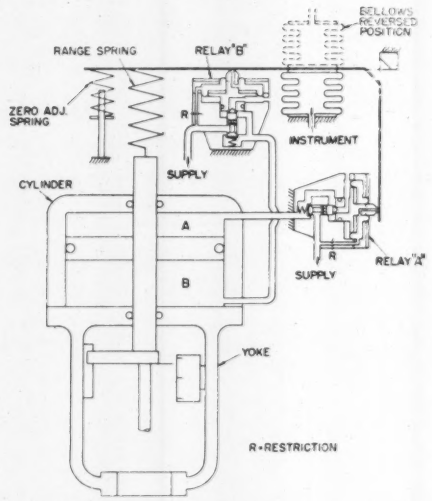
In addition, higher production speeds were possible on Cannon plugs and operators were less subject to painful burns. Send for descriptive literature.

IDEAL INDUSTRIES, Inc. 1420-C Park Ave., Sycamore, Ill. (IDEAL)
Gentlemen: Please send complete catalog information about Ideal's Thermo-Tip Resistance Soldering Tools.
Name_____
Company_____
Address_____
City_____ Zone____ State_____

For more information circle **41** on inquiry card.

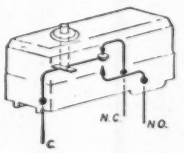
Pneumatically-Operated Piston

The type 470 P.O.P. (Pneumatically Operated Piston) was designed primarily for applications where more force and higher stroking speeds are required than can be obtained from a diaphragm operator . . . Let us assume that the pressure of the fluid being controlled has increased above the set point. The bellows unit will receive an increased signal from the controller and expand to move the beam . . . Through relay action, the air pressure to the top of the piston, "A" in the sketch, will be increased. Relay "B" will be reacting to the change in beam position to decrease the pressure to the under side of the piston, "B" in the sketch. Due to the unbalanced pressures acting on the piston, it will move down, changing the valve position as dictated by the controller. The piston movement is fed back to the beam by means of a range spring that is connected to the piston rod extension, thus preventing any further build-up of pressure in the cylinder . . . (*From new 4-page Bulletin E-59, Fisher Governor Co., Marshalltown, Iowa.*)



For this literature circle **184** on inquiry card.

Industrial Enclosed Switches



All Micro Switch enclosed switches contain precision snap-action switching units. With each actuation, a movable silver contact, powered by a beryllium-copper spring, snaps from one stationary contact to the other. When the operating force is relieved the movable contact snaps back to its original position. This sequence is repeated with precision exactness for millions of operations . . .

Enclosed general purpose switches have single-pole double-throw contact arrangements and may be wired either normally-open or normally-closed . . . (*From new 20-page Catalog 83c, Micro Switch, a Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill.*).

For this literature circle **185** on inquiry card.

Group Meets to Discuss Need For a Systems Engineering Council

FORTY-TWO persons attended the first preliminary meeting of the proposed Systems Engineering Council. A lively discussion took place until 5:00 p.m. The outcome was an informal resolution that the formation of a Systems Engineering Council might be desirable, and that work towards ultimate organization of the council shou'd continue at a local level. Results of such local organizational efforts will appear in this newsletter put out by the chairman, pro-tem, of the Systems Engineering Council—George H. Amber of Amber & Amber, Automation Systems Consultants, 19925 Schafer Highway, Detroit 35, Michigan.

Following are some comments of this meeting:

Samuel A. Scharf (Consulting Systems Engineer, New York City) encourages formation of a Systems Engineering Council and volunteered to work, on a local level, in New York City.

Philip C. Fetter (President, Automation Industries, Inc.) said that he is interested in the Systems Engineering Council as an aid to systems engineering for industry.

Charles A. Hayne (IT&T Development Laboratories) said that, in his opinion, the Systems Engineering Council should be organized strictly along professional society lines, and to avoid aspects of a trade association.

Edwin Surronen (General Electric Automation Task Force) cast a negative view on the proposed Systems Engineering Council: "I do not see any solution to the stated problems of systems engineering."

Samuel E. Gluck (Director of Research, Bonded Scale & Machine Company) repeatedly pointed out the long-range pitfalls of the proposed Systems Engineering Council, and strongly urged that it take on the role of a company of philosophers.

James E. Dolan (Consultant, Philippines) answered Gluck by pointing out that "cutting down the tree is no way to kill worms in the apples."

Woodrow Floyd (Staff, Hughes Products) and **David G. Kilpatrick** (Staff Engineer, General Atronics Corporation) are interested in the formation of the SEC, and represent the interests of many of the members of their firms. They agreed to take some committee work, reviewing the objectives and proposed organization of the Systems Engineering Council.

Professor Carl Kayan (Mechanical Engineering Department, Columbia University), who was Honorary Chairman of the 4th International Automation Exposition and Congress, sat in the meeting as an observer from the Engineers Joint Council. Professor Kayan pointed out that organization other than on the basis of a professional society could lead to tax complications. He also asked the Chair whether or not the objectives of the proposed Systems Engineering Council could be accomplished by an existing professional society. The Chairman, Amber, replied that the proposed Systems Engineering Council conflicts with no known group and that no professional group was active in this area.

J. J. Baranofsky (Systems Engineer, Raytheon Missile Systems Division) expressed interest in the Systems Engineering Council and offered to undertake some organizational activities.

N. H. Auser (Dept. of Industrial & Management Engineering, New York University) represented the American Institute of Industrial Engineers. Auser was interested in the SEC and requested to be kept informed.

Charles A. Locurto (GE Missiles and Ordnance Systems) encouraged formation of a systems engineering council and suggested that some efforts be made in defining Systems Engineering.

Dr. Ernest A. Keller (Director R & D, Panellit, Inc.) felt strongly that Systems Engineering and Product Engineering and Applications Engineering could not be separated. He did not seem to think that a Systems Engineering Council would be of value to his activities.

Dr. Eugene Mittelmann (Consulting Systems Engineer and Physicist, Chicago) took the view that a systems engineering council was not feasible.

Martin A. Mayers (Sanderson & Porter, Boiler Systems Engineers) pointed out that they would welcome an organization similar to the Systems Engineering Council, if for no other reason than that it would make available a listing of Systems Engineering Consultants available for assignment. Mayers states that a number of small and medium-size plants would prefer to engage consultants for systems work rather than take on staff engineers, but that not enough consultants are known.

Many who did not engage in the lively discussion have expressed interest in the SEC by mail. For example, **Reuben J. Goldman** (Wyatt C. Hedrick, Engineering Corp., Houston, Texas) said in his letter: "We have noticed all too frequently how most clients use consulting service for an entire project, or even component portions, such as chemical, structural, electrical, mechanical, or market reserach, but clients seldom consider using an unbiased consultant for merely a 'control problem.' This aspect is handled often by consulting with an instrument man, who has something to sell. . .

"Although I can't be present for the meeting, we would like to be posted on your progress. Certainly, we will be interested in joining and supporting an organization of this type."

In similar vein, **R. R. Martin** (Manager, Systems Engineering, IBM, Yorktown Heights) writes: "I have a strong interest in this field and would like to assist if a group is organized."

Report of pre-organizational meeting, held 10 June 1958 in the New York City Coliseum (Room 415), 2:30 p.m. (co- incidentally with the 4th International Automation Exposition and Congress.

PLAN NOW to attend the

FIFTH INTERNATIONAL

automation

EXPOSITION & CONGRESS

NOVEMBER 16-20 1959

NEW YORK TRADE SHOW BUILDING

THE SHOW

Displays will feature automatic control systems, digital and analog computers, automatic inspection and testing devices, communication systems, feeding and work positioning mechanisms, machine controls, and electronic, electrical, mechanical and electromechanical components.

EXHIBITOR CLINICS

Each morning, exhibiting companies will conduct clinic sessions of 90-minute duration, in front of operating equipments. Clinics will treat these areas of interest: Computers; Process Automation; Machine-tool Automation; Programming; Dimensional Measurement and control; Materials Handling; Office Automation; Temperature, Pressure & Flow Instrumentation; Servomechanisms; Electromechanical Components; and many others.

TECHNICAL SESSIONS

Especially designed for engineers and executives responsible for automation, sessions are planned to cover: Challenge of Measurement and Control; Data Acquisition and Reduction; Automatic Weighing; Control of Machines, Military Electronics and Controls; Medical Instrumentation; Human Factors in Systems Engineering; Plant Layout for Automation; Contribution of Cybernetics; Office Automation For Senior Officers; and Manufacturing and Automation.

COOPERATING SOCIETY

The ASME Materials Handling Division has scheduled four sessions whose theme will be "Materials Handling as a Key to Profit Potentialities in Automation." They include: Automatic Warehousing; Automatic Materials Handling Systems in Process Plants; Management and Economics Problems in Automation; and Systems Engineering.

MILITARY AUTOMATION

The Second Military Automation will be held concurrently with the Fifth International Automation Exposition and Congress. Special groupings of electronic and control equipment having application to the military is being arranged. Some sessions will be based on these equipments.

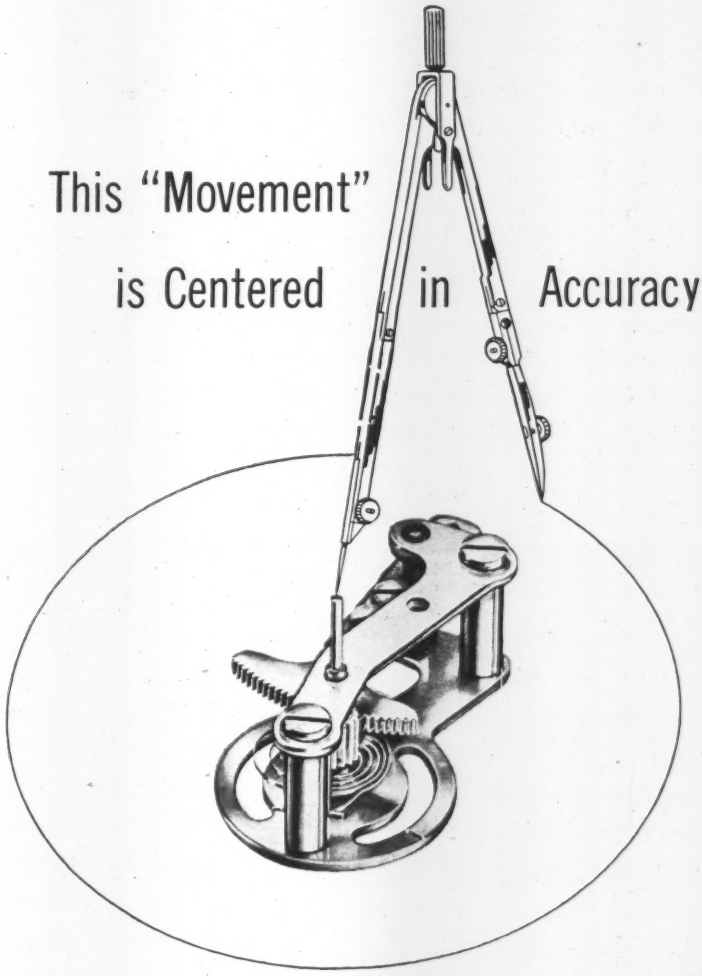
Because the Fifth International Automation Exposition and Congress is principally an educational endeavor, the show management has again selected the New York Trade Show Building as its "ideal" New York Schoolhouse. You'll find the combination of technical sessions, clinic classes and new products exhibited your most rewarding "show" experience of the year. Plan now to count yourself among the 20,000 expected to attend.

Richard Rimbach Associates, Management

FIFTH INTERNATIONAL AUTOMATION EXPOSITION

345 Ridge Avenue, Pittsburgh 12, Penna. Phone FAirfax 1-9831 and 1-9832

This "Movement" is Centered in Accuracy



The rotary movement in Ashcroft Duragauges has a geared center shaft on which the pointer is mounted. When pressure flexes the Bourdon tube, the pointer is always positively positioned. You can rely on the Duragauge for precise accuracy in measuring pressure no matter how severe the conditions of service.

Correct calibration is guaranteed: the one-piece link between movement and Bourdon tube prevents slippage or parting under tension. Recalibration is easy from front or rear. Universal adjustability permits uniformly graduated dials.

You can order Ashcroft Duragauges with all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. A complete choice of Bourdon tube materials, pressure ranges, dial sizes and case designs and materials is available. Your industrial supply distributor will gladly help you select the best combination for your requirements. So, be certain of highest sustained accuracy, durability and economy – specify Ashcroft Duragauges.

Ashcroft Duragauge in Alumalife® case—a lifetime case made of special aluminum alloy.

MAXWELL M&M MANNING & MOORE INC. TRADE MARK

G1-58

ASHCROFT PRESSURE GAUGES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more information circle **44** on inquiry card.

PLAN NOW to attend the

FIFTH INTERNATIONAL

automation

EXPOSITION & CONGRESS

NOVEMBER 16-20 1959

NEW YORK TRADE SHOW BUILDING

THE SHOW

Displays will feature automatic control systems, digital and analog computers, automatic inspection and testing devices, communication systems, feeding and work positioning mechanisms, machine controls, and electronic, electrical, mechanical and electromechanical components.

EXHIBITOR CLINICS

Each morning, exhibiting companies will conduct clinic sessions of 90-minute duration, in front of operating equipments. Clinics will treat these areas of interest: Computers; Process Automation; Machine-tool Automation; Programming; Dimensional Measurement and control; Materials Handling; Office Automation; Temperature, Pressure & Flow Instrumentation; Servomechanisms; Electromechanical Components; and many others.

TECHNICAL SESSIONS

Especially designed for engineers and executives responsible for automation, sessions are planned to cover: Challenge of Measurement and Control; Data Acquisition and Reduction; Automatic Weighing; Control of Machines, Military Electronics and Controls; Medical Instrumentation; Human Factors in Systems Engineering; Plant Layout for Automation; Contribution of Cybernetics; Office Automation For Senior Officers; and Manufacturing and Automation.

COOPERATING SOCIETY

The ASME Materials Handling Division has scheduled four sessions whose theme will be "Materials Handling as a Key to Profit Potentialities in Automation." They include: Automatic Warehousing; Automatic Materials Handling Systems in Process Plants; Management and Economics Problems in Automation; and Systems Engineering.

MILITARY AUTOMATION

The Second Military Automation will be held concurrently with the Fifth International Automation Exposition and Congress. Special groupings of electronic and control equipment having application to the military is being arranged. Some sessions will be based on these equipments.

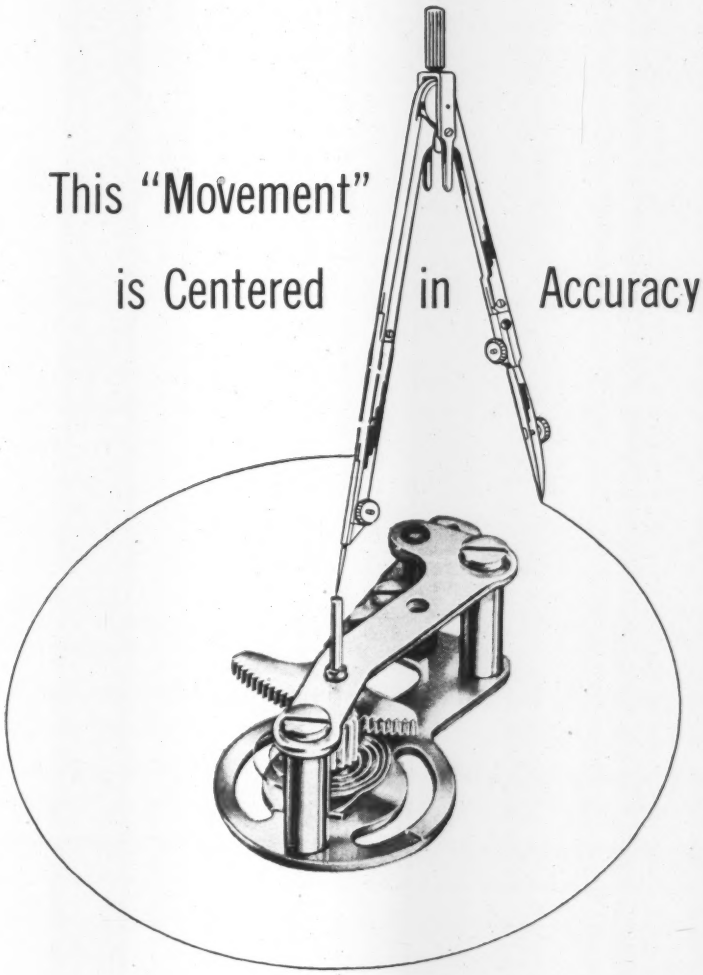
Because the Fifth International Automation Exposition and Congress is principally an educational endeavor, the show management has again selected the New York Trade Show Building as its "ideal" New York Schoolhouse. You'll find the combination of technical sessions, clinic classes and new products exhibited your most rewarding "show" experience of the year. Plan now to count yourself among the 20,000 expected to attend.

Richard Rimbach Associates, Management

FIFTH INTERNATIONAL AUTOMATION EXPOSITION

845 Ridge Avenue, Pittsburgh 12, Penna. Phone FAirfax 1-9831 and 1-9832

This "Movement" is Centered in Accuracy



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Ashcroft Duragauge in Alumalife® case—a lifetime case made of special aluminum alloy.

MANNING MAXWELL & MOORE INC. TRADE MARK

G1-58

ASHCROFT PRESSURE GAUGES

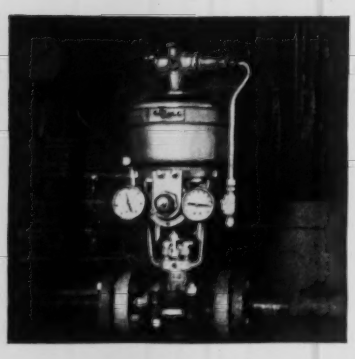
A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more information circle **44** on inquiry card.

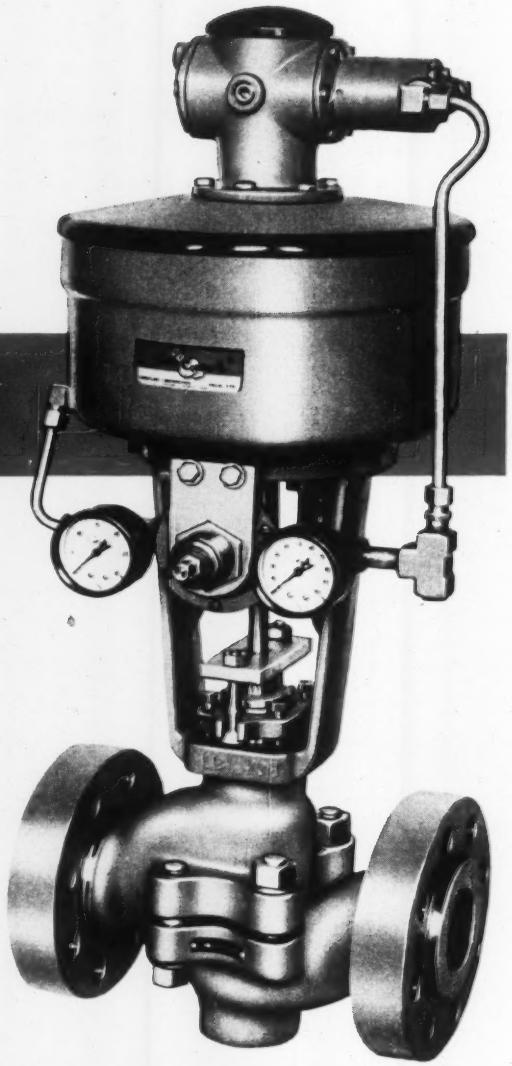


"Best valves we ever found for tight shutoff on our maleic acid lines" says Instrument Foreman of a well-known mid-west chemical plant.

YOU CAN COUNT ON

CONOFLOW LB CONTROL VALVES

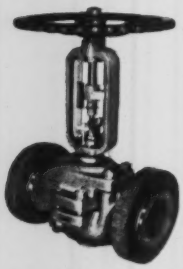
FOR TIGHT SHUTOFF



Major chemical companies have switched to Conoflow Series LB Control Valves because they provide absolute tight shutoff, regardless of operating variables. Tight shutoff prevents waste of costly liquids and gases . . . insures precise process control.

The answer is the single-seated body and the powerful cylinder actuator of the LB Valve. This integrated body-actuator design allows for leak-proof shutoff not possible with double-seated valves.

An added feature of the LB Valve is much lower all-around maintenance costs. Body separates easily at seat ring for tear down and inspection. Fewer replacement parts mean substantial inventory savings. Streamlined body contours and extra thick walls assure longer life in corrosive and erosive services. Also, when it comes to special alloys . . . type 316 Stainless steel, Hastelloys, Monel, Nickel, Everdur, etc., the single-seated LB Valve offers a substantial initial cost advantage over double-seated construction. By all standards, your overall cost is much less for a Conoflow Series LB Valve.



Also available with sturdy handwheel actuators for precise manual control.

If you are not already a user, try a Conoflow LB Control Valve . . . and let it prove itself.

Phone your nearest Conoflow representative (located in principal cities), or write to Conoflow Corporation, 2100 Arch Street, Philadelphia 3, Pa. for Bulletin LB-3-1A

Cono Controls®

CONOFLOW CORPORATION

FOREMOST IN FINAL CONTROL ELEMENTS

WALWORTH

For more information circle **45** on inquiry card.

solving today's problems today: Burroughs 220 Computer

In scientific computation and business data processing, the new Burroughs 220 is delivering tangible results today. Linking a powerful digital computer to equally powerful input-output subsystems, the 220 offers balanced performance at the lowest application cost. Its expandable core memory, built-in floating decimal arithmetic, vast Datafile magnetic tape capacity and the multiple-card processing ability of Cardatron make this the most powerful system available in the medium price field. The 220 is just one part of a complete line of advanced Burroughs electronic data processing equipment...now in production...now at work in hundreds of installations...supported by an outstanding team of computer specialists. Write today for 220 brochure, ElectroData Division, Pasadena, California.

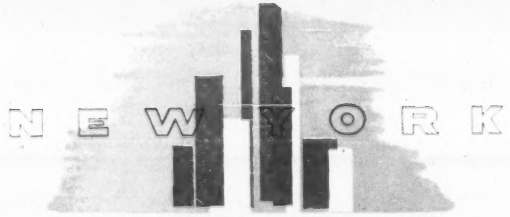
Burroughs Corporation

"NEW DIMENSIONS/in electronics and data processing systems"

For more information circle **46** on inquiry card.

"the show of the future"

FIFTH INTERNATIONAL automation EXPOSITION



NOVEMBER 16-20, 1959

Plan NOW to exhibit at the Fifth International Automation Exposition

As the nation's leading "automation" show, the Fifth International Automation Exposition is ideal for displaying equipment, components, and systems associated with industrial and scientific instrumentation, machine-tool control, computing, data and materials handling, and conveying.

Scheduled for November 16 to 20, 1959, at the New York Trade Show Building, the Exposition will again attract thousands of top executives and technical personnel from all industries.

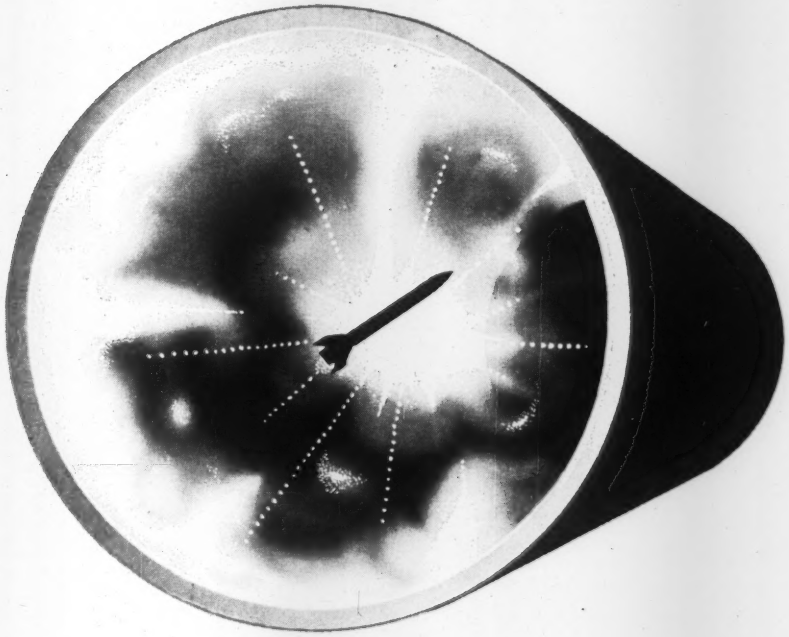
Unique features of the New York Trade Show Building enable all exhibitors to schedule "clinics" for instructing selected audiences on the fine points of their equipment . . . in complete privacy . . . and featuring the equipment itself!

Make room now, in your promotion budget, for this most important show. Write for full details, and breakdown of attendance at previous International Automation Expositions.

Richard Rimbach Associates, Management

FIFTH INTERNATIONAL AUTOMATION EXPOSITION

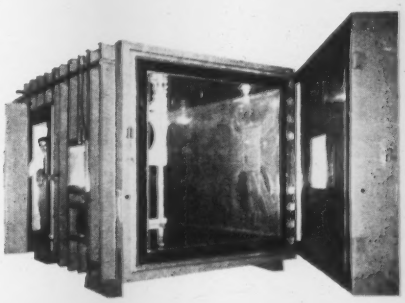
845 Ridge Avenue, Pittsburgh 12, Penna. Phone FAirfax 1-9831 and 1-9832



You name the environment ...TENNEY will simulate it!

Altitude, heat, cold, explosion, vacuum ... whatever environment you need, there is an extensively-tested Tenney prototype already built that is very near your specifications. By adjusting the prototype to fit your particular requirements, we can make delivery in a surprisingly short time. In operation, your Tenney chamber will reach ideal environmental conditions quickly, maintain them efficiently throughout the test run, and provide accurate data for quick, simple evaluation.

Tenney, pioneer in the science of environmental testing, is today the world's largest, most experienced creator of environmental testing equipment. Write today for literature describing Tenney's complete line of prototype chambers, or for information on Tenney's research and development, engineering consultation, and design services.



Tenney
ENGINEERING, INC.
1090 SPRINGFIELD ROAD, UNION, N. J.

PLANTS: UNION, N. J. AND BALTIMORE, MD. • THERE IS A TENNEY CHAMBER TO SIMULATE ALTITUDE, HEAT, COLD, HUMIDITY, VACUUM, EXPLOSION, SAND, DUST, FOG, AND MOST OTHER ENVIRONMENTAL CONDITIONS.

For more information circle **47** on inquiry card.

panhandle pete

The ABC's of SE

"THESE trade journals sure are wonderful," says Waldo Klappsaddle, our genial sales manager, one day recently.

"Oh?" queries I, "I find them just a bit hard to understand lately."

"Just in places," replies Waldo. "In other places they let you know what is going on in other fields—in simple manner, too. For example, look at this nice writeup of the fine things that are going on in the field of Machine Linguistics, which is referred to by those who count as ML."

"They really are doing a fine job," says I, as I picked up the article and read all about Machine Abstracts (MA), Machine Retrieval (MR), and Machine Translation (MT).

"Our Field could really learn from this new high-powered field," says Waldo, who always is looking for ways to advance the state of our art—that's WESCO! of course.

"In what way?" I asks.

"We are as high powered as those jokers," answers Waldo. "And we work on as many important devices as they do. We could simplify the field, upgrade all those in it—and keep others out of it—by using the same technique. We should always call a pneumatic control valve a PCV from now on, a pneumatic proportional process controller a PPPC, with reset it is PPPC with R, and with derivative control it is a PPPCR with RD. A closed-loop control system with this controller and pneumatic control valve would then be a CLCS with PPPCR with RD and PCV. Ain't that simple—and wonderful?

"Just what is so wonderful about it?" I asks, being in a skeptic mood.

"Pete, that's why you are just an instrument peddler instead of a much-quoted leader of our field. No vision. Any old instrument man can adjust the proportional band (PB) of a pneumatic proportional controller (PPC) with reset and rate (RR) to match the time lag (TL) of a closed loop process control system (CLPCS). But only an SE (system engineer) could adjust a PB of a PPC with RR to match the TL of a CLPCS."

"Waldo, this will earn you an honored place in the anals of our industry," I admits—"you will live forever as one of the many greats who have earned a reputation by putting the BS into SE." *Panhandle Pete*

Combat Operations Research Group

CONARC

This is to Certify

Dr Otto Uber Alles BS, BA, MA, SB, CORG, JHU

In unauthorized recognition of a tour of 2.71828 months as a member

CORG

is from this day awarded the degree of

Honorary Doctor of Diligent Research Operations

quam minime dedecore

with all the rights, eccentricities and epistemological insight of a real scientist thereunto appertaining.

In witness thereof is affixed the circumperambulating seal of CORG

D. W. Meals ..... Director

J. P. Murdock Jr. ..... Asst. Director

W. Washburne ..... Witness

October 17, 1957 ..... Date

Fort Monroe, Virginia

tech/ops

Thanks, to our many fans throughout the world who participate in and enjoy this nonsense each month. Thanks too to the CORG gang who went to so much trouble to compose this citation (above) ..... *Panhandle Pete*

tech/ops CORG

COMBAT OPERATIONS RESEARCH GROUP CONARC FORT MONROE, VIRGINIA

The Editor
Instruments and Automation
Executive and Editorial Office
845 Ridge Avenue
Pittsburgh 12, Pennsylvania

Dear Sir:

We, at the Combat Operations Research Group (CORG), were surprised and pleased to discover in the September issue of "Instruments and Automation" a recent photograph of our distinguished alumnus, Dr. Otto Uber Alles, BS, BA, MA, SB, CORG, JHU.

Initially, Dr. Alles was highly regarded at CORG for his penetrating analyses of Quandom Mechanics; however, a shadow was cast on his professional competence during his last days with us. We observed that he spent most of his working hours, and many of his non-working hours, in a local library. Our confidence in assuming that he was engaged in scientific activities was shaken by our knowledge that the librarian was a locally infamous non-linear model. His replies to our queries vaguely referred to an activity he called "twottling." We now know our suspicions were unfounded. He was not, as we had believed, the first casualty of TAG, CORG's latest computer-played war game.

Dr. O. U. Alles deserves the degree, "CORG," you list among his other honors. Moreover, his achievements as described by "Panhandle Pete" deserve further recognition. We are, therefore, forwarding for Dr. O. U. Alles the diploma our suspicions caused us to withhold. We hope Dr. Alles will forgive us.

Incidentally, we observe in Dr. Alles' picture an apparent awareness of the world -- a suggestion of contact with reality. We wonder if he has changed as radically in other respects. Are all his wives still living with him? Does he still relish chocolate covered grasshoppers? Does he still insist on performing his calculations with ordinary house paint and a 4" brush? We would appreciate further information, if it's printable.

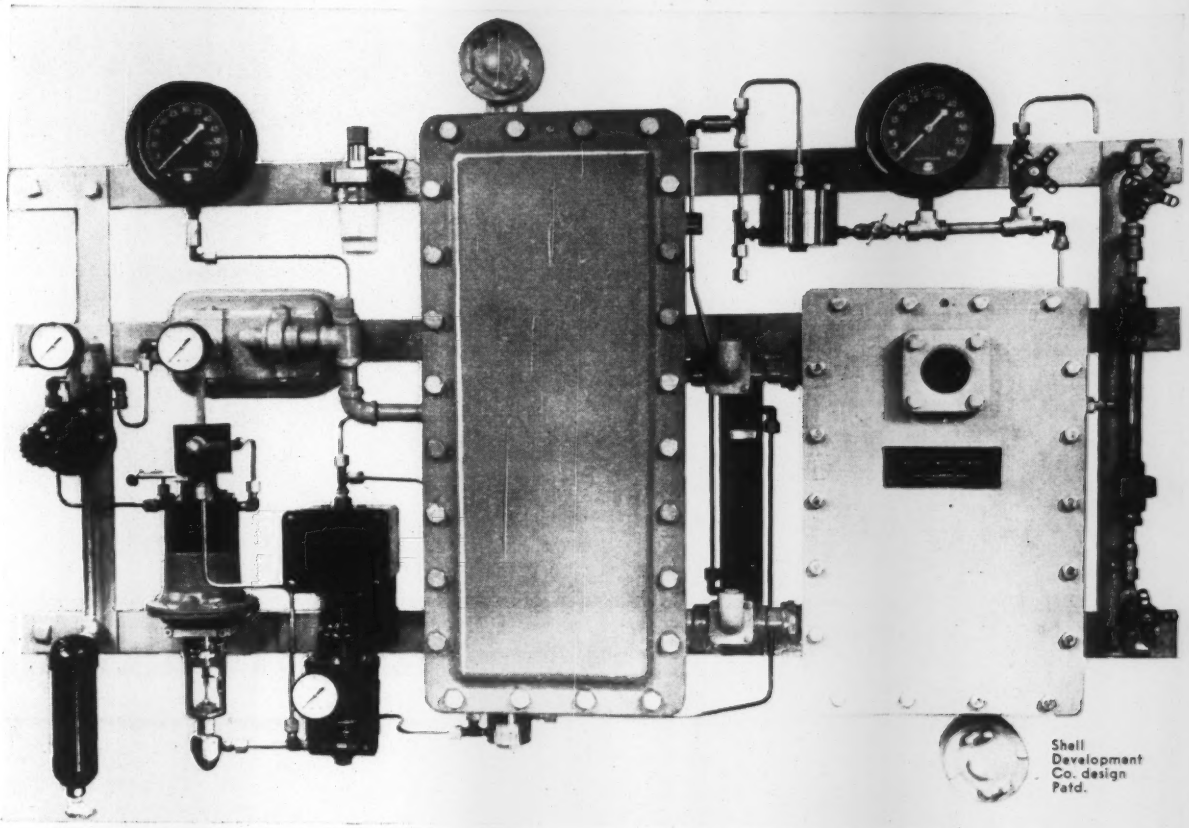
Very sincerely yours,

D. W. Meals

D. W. Meals
Director

Enclosure

Operated under
DEPARTMENT OF THE ARMY CONTRACT
between
HQ. CONTINENTAL ARMY COMMAND
and
TECHNICAL OPERATIONS, INC.



This Continuous Vapor-Pressure Recorder PAYS OUT in one to three months

It continuously samples and records the vapor pressure of gasoline or liquefied gases in a flowing stream.

Elimination of laboratory tests alone pays the whole cost of the Continuous Vapor-Pressure Recorder installation in as little as one month. After that, the savings show up in economy in production.

This instrument is simple, reliable, and needs but occasional maintenance.

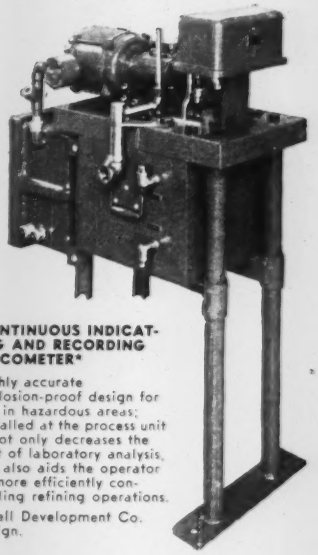
Hallikainen Instruments, well-known specialists in the manufacture of instruments for refineries are proud to announce this instrument. Write for full technical details now, and judge for yourself how this instrument can save money for your refinery. Ask us for all the facts on the Continuous Vapor-Pressure Recorder.

Other money-saving precision products made by Hallikainen Instruments:

Initial Boiling Point Recorder* is used to measure initial boiling points of light hydrocarbons.

Sulfuric Acid Analyzer (for Alkylation Plants) continuously samples an alkylation acid stream and measures acid strength. Saves as much as $400 a day on replacement acid.

Color Alarm* provides an alarm or visual signal when color limit is exceeded.



CONTINUOUS INDICATING AND RECORDING VISCOMETER*

highly accurate explosion-proof design for use in hazardous areas; installed at the process unit it not only decreases the cost of laboratory analysis, but also aids the operator in more efficiently controlling refining operations.

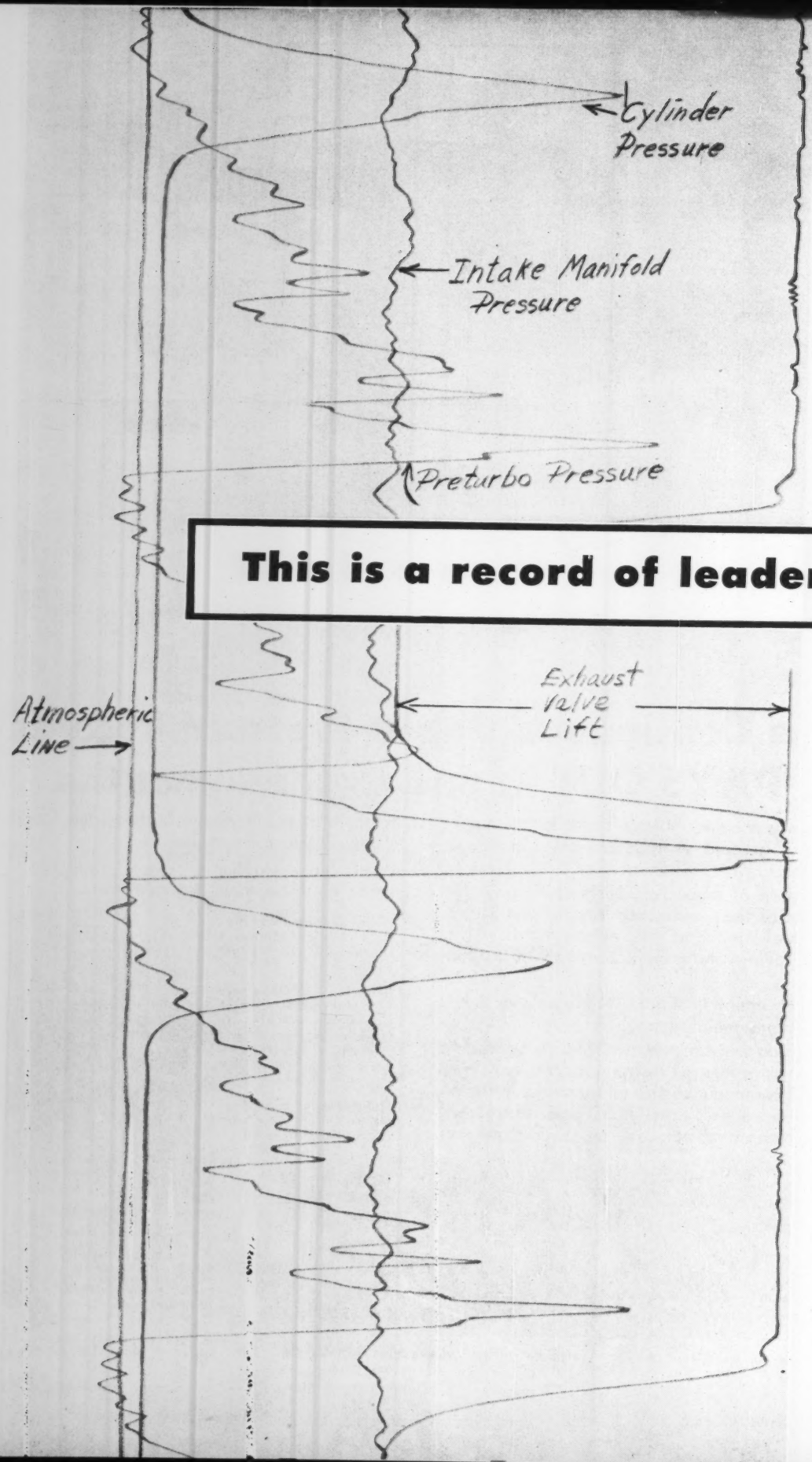
*Shell Development Co. design.

HALLIKAINEN *Instruments*

1341 SEVENTH STREET • BERKELEY 10, CALIFORNIA

See our Exhibit at the 5th World Petroleum Congress Exposition, New York Coliseum, June 1st to 5th.

For more information circle **48** on inquiry card.



This is a record of leadership

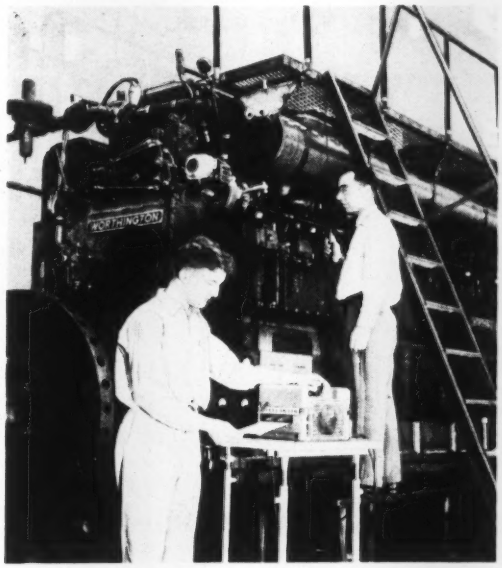
The Worthington Corporation used a Honeywell 906 Visicorder to chart the heartbeat of a Worthington Tripower diesel engine. These Tripower (oil fuel, dual fuel, or spark ignition gas) engines have a fourteen inch bore, an eighteen inch stroke, and develop more than 265 h.p. per cylinder at 450 RPM.

The Visicorder used in these tests makes a direct, instantly-readable record of the pressure variations in the exhaust manifold, cylinder, and intake manifold to determine optimum valve timing and engine configuration. The Visicorder also produces a permanent record of strain gauge measurements taken on the frame and other critical engine parts.

For the manifold and cylinder pressures, strain gauge pressure transducers and a strain gauge amplifier were used. For the valve lift patterns, a linear potentiometer powered with a small battery was connected directly to the Visicorder.

Analysis of these data has led to changes in the Tripower engine for best performance.

in diesel engine research



Ted Dupler (left) and John McAllister, Worthington Engine Research Engineers, measure intake manifold, cylinder, and exhaust manifold pressures and valve stroke on a Tripower with a Honeywell 906 Visicorder.

The Honeywell Visicorder is the pioneer and unquestioned leader in the field of high-frequency, high-sensitivity direct recording oscillography. In research, development and product testing everywhere, instantly-readable Visicorder records are pointing the way to new advances in product design, rocketry, computing, control, nucleonics . . . in any field where high speed variables are under study.

The new Model 906A Visicorder, now available in 8- and 14-channel models, produces longitudinal grid lines simultaneously with the dynamic traces, time lines, and trace identification by means of new accessory units.

To record high frequency variables—and monitor them as they are recorded—use the Visicorder Oscillograph. Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

Reference Data: Write for Visicorder Bulletin
Minneapolis-Honeywell Regulator Co.,
Industrial Products Group, Heiland Division
5200 E. Evans Ave., Denver 22, Colo.

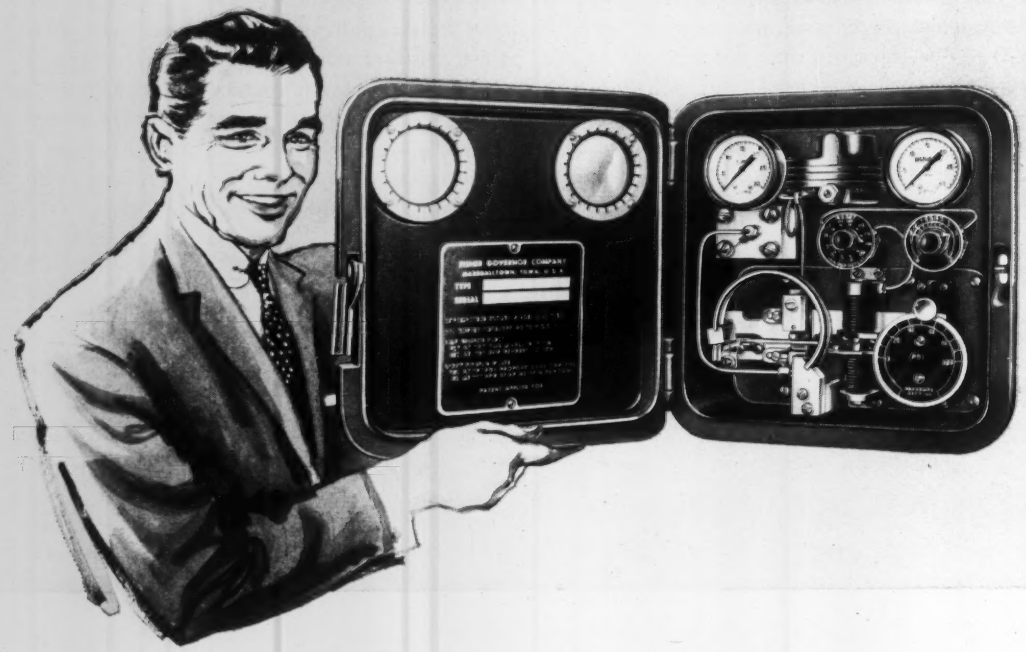
Honeywell

Industrial Products Group

For more information circle **49** on inquiry card.

So many ways the ***FISHER/MAN***
can give you a helping hand with the

WIZARD II
PRESSURE CONTROLLERS



- Two Position Controller
- Proportional Controller
- Proportional Controller —Remote Set
- Differential Proportional Controller
- Pressure Transmitter
- Differential Proportional Controller— Remote Set
- Proportional Reset Controller
- Differential Proportional Reset

This "Jack of ALL Trades" is surprisingly low in cost

The partial list of applications at left tells you why the Wizard II is so aptly named. Probably no other controller in the Fisher line is as versatile. Available in brass, steel or stainless steel Bourdon tubes for ranges from 25 to 10,000 psi. Brass or stainless steel bellows available for low pressure service from 30″ Hg Vacuum to 30 psi.

Fisher has carefully designed each component of the new Wizard to satisfy the most rigid process control requirements. A completely descriptive and illustrated booklet on the Wizard II is yours for the asking. Write for Bulletin D 4150 A.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD... CHANCES ARE IT'S CONTROLLED BY...

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario / London, England

CONTINENTAL EQUIPMENT CO. DIVISION, Coraopolis, Pennsylvania

FISHER®

SINCE 1880

For more information circle **50** on inquiry card.

Replace your awkward, obsolete needle valves!

NOW— ON-OFF at 3000 PSI with new quarter-turn FLO·BALL plug valve

. . . priced no higher than needle valves!

Hydromatics Series 715 Spherical Plug Valve breaks through 150 PSI limitation of ordinary plug valves!

- **LOW TORQUE, EASY ACTION**... Quarter-turn operation, requiring only 4 lb-in torque at 3000 PSI.
- **MAXIMUM FLOW EFFICIENCY**... Straight-thru FLO·BALL design has more than twice the flow of needle valves.
- **POSITIVE ON-OFF INDICATION**...The large, arrow-shaped handle shows valve position at a glance.
- **ZERO LEAKAGE**... Mass Spectrometer tests with Helium prove zero leakage.
- **UNIVERSAL MOUNTING**...Can be panel, side, bottom or line mounted.
- **REMOVABLE FLANGES**... Replace damaged flanges in seconds—no need to scrap entire valve.
- **VERSATILE SERVICE**... Leak-proof control of air, vacuum, steam, water, fuels, oils, kerosene, alcohol and many other media.

PORT STYLES AND SIZES

NPT		AND10050	
Size	Part No.	Size	Part No.
1/8	715A1	1/4	715A2
1/4	715B1	3/8	715B2

NOTE — Other models are available for service with cryogenic and corrosive media. Also special designs for throttling flow control.

ALL STAINLESS STEEL CONSTRUCTION — COST NO MORE THAN OLD FASHIONED SCREW-TYPE VALVES!

NEW CATALOG!

WRITE, PHONE or TWX for Hydromatics' new catalog, describing the world's most complete line of precision valves for industrial and military applications.

HYDROMATICS, INC., 70 OKNER PARKWAY, LIVINGSTON, N. J.
Phone WYman 2-4900 • TWX Livingston NJ 120

Hydromatics, Inc.

Pasadena: 35 N. Arroyo Pkwy., RYan 1-7448 • Washington, D.C.: 1413 K St., N.W., STerling 3-3612 • Seattle: GLencourt 4-0577 • Indianapolis: 889 E. 82nd St., CLifford 1-5287

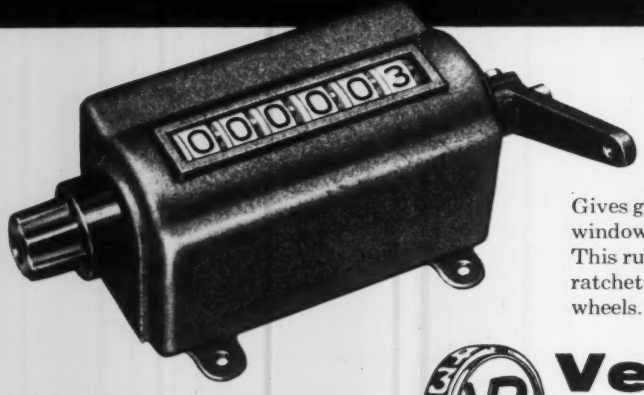
For more information circle 51 on inquiry card.

How to help your customers COUNTrol their production

Do your customers complain of spotty production . . . short-runs, over-runs, uncertain quality control, uneven performance from your machine or product? If so, there's one thing you can do about it . . . build a Veeder-Root Counter into your product as a standard integral part. Then you can offer your customers constant visual *Count*rol of your product's performance . . . which amounts to recorded proof of your product's guarantee.

You'll find, too, that built-in counters build up sales. And you can count on us to "teach your product to count". Write.

You always "Know the score" when you count on Veeder-Root!



NEW "VISICOUNTER"

Gives greater figure-visibility with dome-shaped window. Better suited for panel mounting. This rugged, heavy duty counter comes in both ratchet and geared types. 6 non-overthrow wheels. 1-piece case.

Everyone can Count on

Veeder-Root Inc.

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Hartford, Conn. • Greenville, S. C. • Altoona, Pa. • Chicago
New York • Los Angeles • San Francisco • Montreal
Offices and Agents in Principal Cities

For more information circle **52** on inquiry card.

NC NORWOOD CONTROLS

PRESSURE TRANSDUCERS

BONDED STRAIN GAGE RUGGEDNESS
2000 cps vibration and 1000 g acceleration any axis

HIGH DYNAMIC RESPONSE
natural frequency 50 kc
damping constant (cooled) .2

AIR or WATER COOLING
gas temperature 5000°F 11 BTU/IN²/SEC

FOUR-ARM 350 Ω STRAIN GAGE BRIDGE
also 2 arm 700 and 1000 Ω bridges

all-welded diaphragm for corrosive applications

HIGH reliability, **LOW** maintenance

Write for Data Sheets covering Norwood Controls Transducers . . . Norwood Controls Unit, Detroit Controls Division, 937 Washington St., Norwood, Mass.

American-Standard PRODUCTS
AMERICAN-Standard
DETROIT CONTROLS DIVISION

For more information circle **53** on Inquiry card.

Photos by Robert Yarnall Richie

Designed, engineered and constructed by The Lummus Company, this giant petrochemical complex at Lake Charles, La., has three separate control rooms. The compressor and boiler unit is controlled by 38 Microsen control loops. 141 other loops measure variables to control ethylene processing, and 75 more control the ethylene oxide-glycol unit. Kybernetes data read-out equipment is integrated with Microsen instruments in one of the control rooms.

For more information circle **54** on inquiry card.

Over 250 Microsen® loops automate processes at Petroleum Chemicals, Inc. and Calcasieu Chemical Corp.

Microsen Electronic Process Instrumentation measures and controls temperature, pressure, flow, and liquid level in this new $80,000,000 installation. Microsen, the DC control system pioneered by Manning, Maxwell & Moore, Inc., was selected for quality of control and ease of installation.

Standard Microsen instruments are used in cascading. By adding ratio amplification in the output of master Controllers, special variable cascade units are created.

The process boiler installation is unique in the use of electronic instrumentation to control both air and gas supply. A special bipolar accelerating amplifier provides zero output under stable process conditions for the three-element feed-water boiler controls.

If a process upset occurs, the amplifier increases output in the indicated direction to correct the deviation. Amplifier output then decays to zero. Decay time is continuously adjustable within a range of .05 to 5.0 seconds.

Field wiring from Transmitters and Valve Positioners is carried in explosion-proof conduit which terminates in ducts at the rear of the panels in each control room. Wiring from ducts to panel instruments is covered with flexible rubber.

Microsen Electronic Process Controls assure permanent savings. They instantly transmit accurate measurements over long distances – assure process stability and efficiency. The DC signal (1.0 to 5.0 ma) is compatible with practically all data handling, telemetering and computing systems, and with process stream analyzers being developed. Microsen design flexibility anticipates ever-changing needs in process control.

Be certain of closer process control. Step up product quality and quantity. For new plant, new process or revamped old process, automate with the Microsen Electronic System. Learn how profitable it can be. Write for information or call in one of our sales engineers.

MAXWELL MANNING M&M & MOORE INC. TRADE MARK

MICROSEN ELECTRONIC CONTROLS

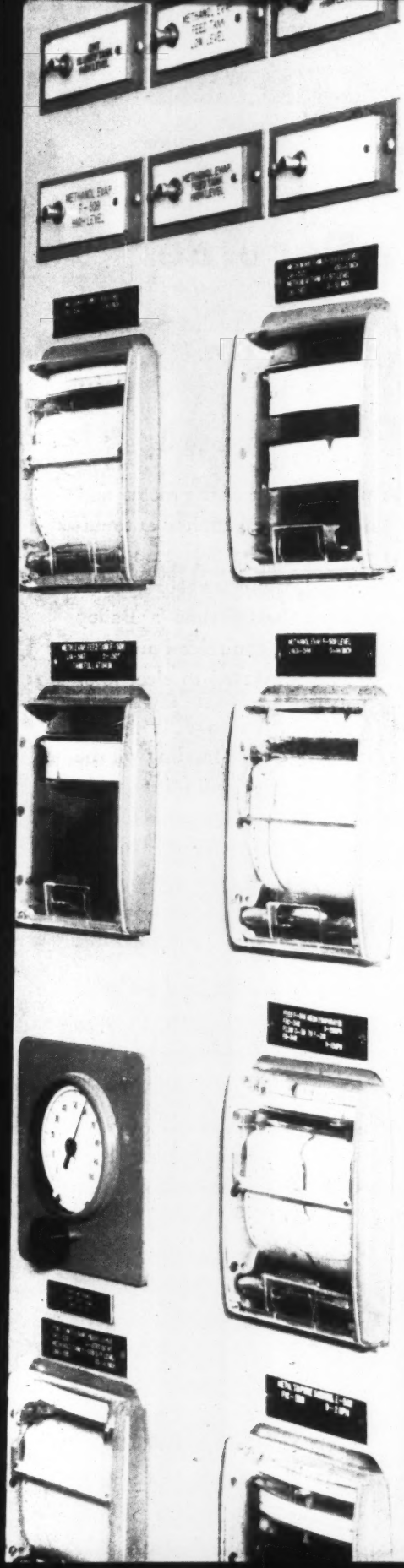
A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more information circle **54** on inquiry card.

Foxboro Pneumatic Consotrol Control Panel at Hercules Powder Company, Burlington, N. J. This Foxboro panel is arranged in a 180° arc so operators can spot warning lights from any position. Continuous air purge in control room eliminates need for explosion-proof electrical switches, alarms, and signal lights.



Hercules Powder Company reports:

175 Pneumatic Consotrols* on stream three years

"—not a single unscheduled shutdown"

At the Hercules plant in Burlington, New Jersey, they're producing millions of pounds of di-methyl teraphthalate a year. Foxboro Pneumatic Consotrol indicators, recorders and controllers provide the instrumentation for the entire multi-million dollar plant.

Hercules operators find their Consotrol instruments perfect for the job. They like the ± 1% accuracy of control they get. What's more, they're able to service an M/58 Consotrol Controller—even to a complete disassembly—and have it back in operation in just a few minutes. And they can convert a Consotrol indicator to a recorder by simply inserting a chart drive mechanism.

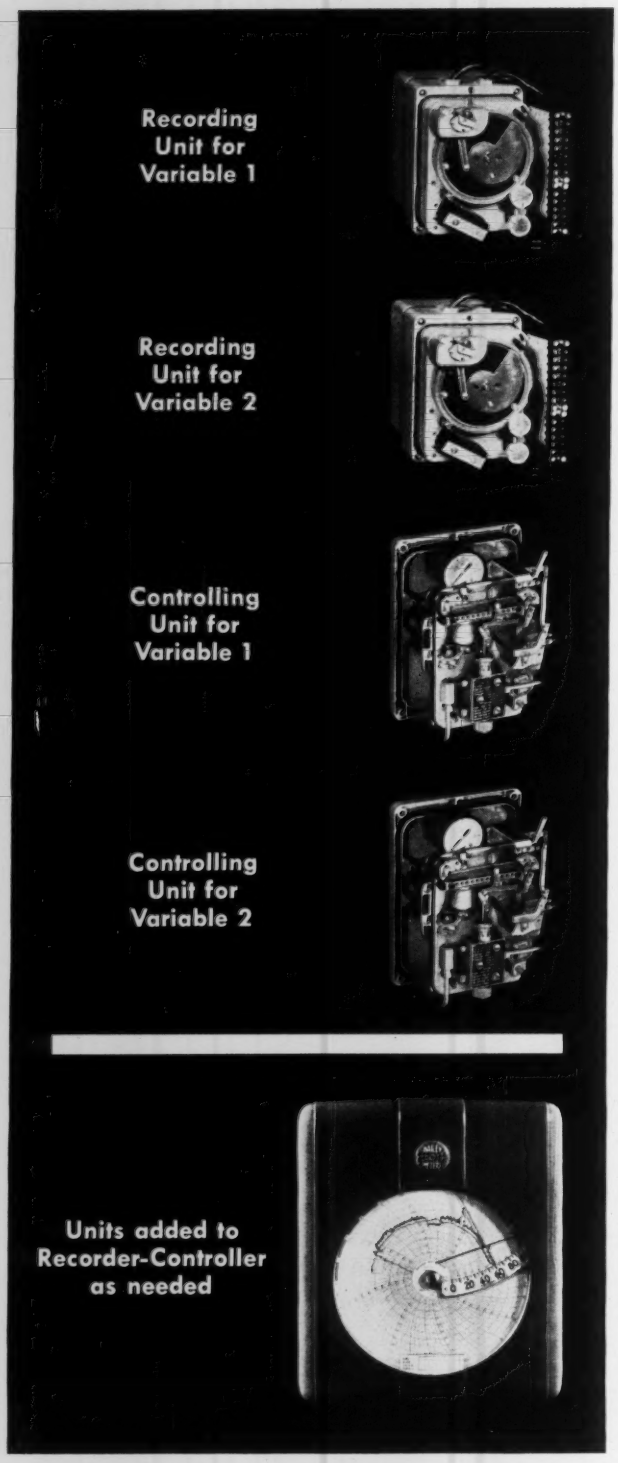
Get the full story on these low-maintenance, accurate Consotrol Recorder-Controllers before you design your next control system. Write for Bulletin 13-18—it has all the details. **The Foxboro Company, 463 Norfolk St., Foxboro, Mass.**

*Reg. U.S. Pat. Off.

FOXBORO
REG. U.S. PAT. OFF.

pneumatic Consotrol instrumentation

For more information circle **55** on inquiry card.


Recording Unit for Variable 1
Recording Unit for Variable 2
Controlling Unit for Variable 1
Controlling Unit for Variable 2
Units added to Recorder-Controller as needed

Bailey Recorder is key to "step-by-step" automation

When you are pioneering a new process and don't know all the answers, complete automation is seldom practical. The first step is to identify your variables and measure them. Nothing does this job better than a Bailey Recorder. One instrument can record any four variables that can be converted to electric *or* pneumatic signals.

Once you get a better understanding of the variables in your process, you will want to add controls and feed back your measurements. Here's where the versatility of the Bailey Recorder comes into play. For the same Bailey instrument you use to record variables is designed to accommodate plug-in control units.

When you use a Bailey Recorder, you can build your instrumentation along with your process. At the start, you use only the plug-in units for recording. Then you add plug-in controls as you see the need for them.

For the complete story of how you can use a Bailey Recorder for step-by-step automation, see your Bailey Engineer.

G-42-1

Instruments and controls for power and process

BAILEY METER COMPANY

1041 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

BAILEY METERS

For more information circle **56** on inquiry card.

book reviews

A Simplified Technique of Control System Engineering, Brown Instruments Div., Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Phila. 44, Pa., by George K. Tucker and Doris M. Wills, 303 pages, $5.00. Uses a non-mathematical approach to an understanding of process control and a graphic method for dynamic analysis of industrial instrumentation systems.

Process Dynamics, by Donald P. Campbell. [C 1958.] John Wiley & Sons, New York 16, N. Y. 316 p. $10.50. 9¼ in. Not for the beginner in process control: the user must have some knowledge of differential equations and the Laplace transformation. Chapters deal with kinematics of handling materials, fluids in motion, and dynamics of thermal processes, mass transfer, and chemical processes.

Magnetic Recording Techniques, by W. Earl Stewart. 1958. McGraw-Hill Book Co., New York 36, N. Y. 272 p. $8.50. 9¼ in. Has a chapter on ferromagnetism and deals with magnetic recording processes, media, mechanisms and standards, and with the magnetic reproducing process. Primarily for engineers. Mathematics held to a minimum.

Basics of Digital Computers, by John S. Murphy. 3v. [1958.] John F. Rider, New York 1, N. Y. 116 + 133 + 136 p., unbound. $2.50 per volume; set $6.95. 9 in. Copiously illustrated in what is called a "picture book" course.

Gas Chromatography, edited by Vincent J. Coates, Henry J. Noebels and Irving S. Fogerson. 1958. Academic Press, New York 3, N. Y. 323 p. $10. 9¼ in. Proceedings of an international symposium held by the Instrument Society of America at Michigan State University in August 1957. Papers by some forty contributors. Considerable attention to apparatus and instrumentation.

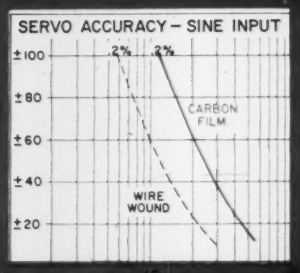
Handbook of Electronic Circuits, by RCA Service Company. 1958. Howard W. Sams & Co., Indianapolis 6, Ind. 66 p. $1. 11 in. A manual intended to aid in recognition of a fundamental circuit when combined in a diagram with other circuits. Includes also an analysis of each circuit with attention to the most common causes of failure.

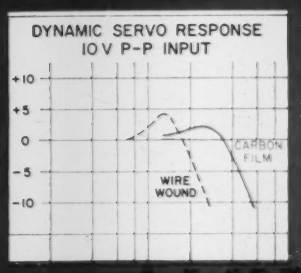
C I C COMPUTER INSTRUMENTS CORPORATION

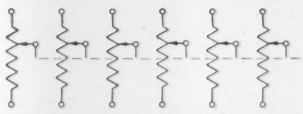
FIRST IN FILM POTS

WITH CARBON FILM POTS

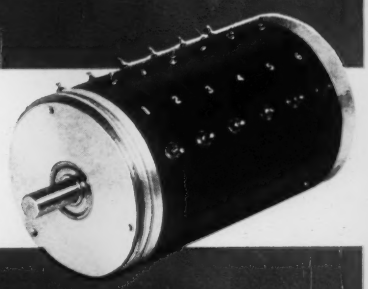
Servo 100% Faster







SIX-GANG POT MODEL 205



PROBLEM

Poor resolution and loss of output signal due to wiper bounce of its wire-wound pots limited the speed of servo multipliers in an Analog Computer. This poor dynamic performance, due to the use of wire-wound pots, threatened to obsolete the entire Analog Computer.

SOLUTION

The substitution of the C.I.C. Carbon Film Pot, with its infinite resolution, low torque, and zero wiper bounce at high speeds, permitted a great increase in amplifier gain with a 100% improvement in dynamic response of the servo multipliers.

	OLD WIRE-WOUND	NEW CARBON FILM
Maximum Velocity	1400 volts/sec	4000 volts/sec
Maximum Acceleration	56000 volts/sec²	150000 volts/sec²
Multiplication Accuracy	± .24%	± .2%

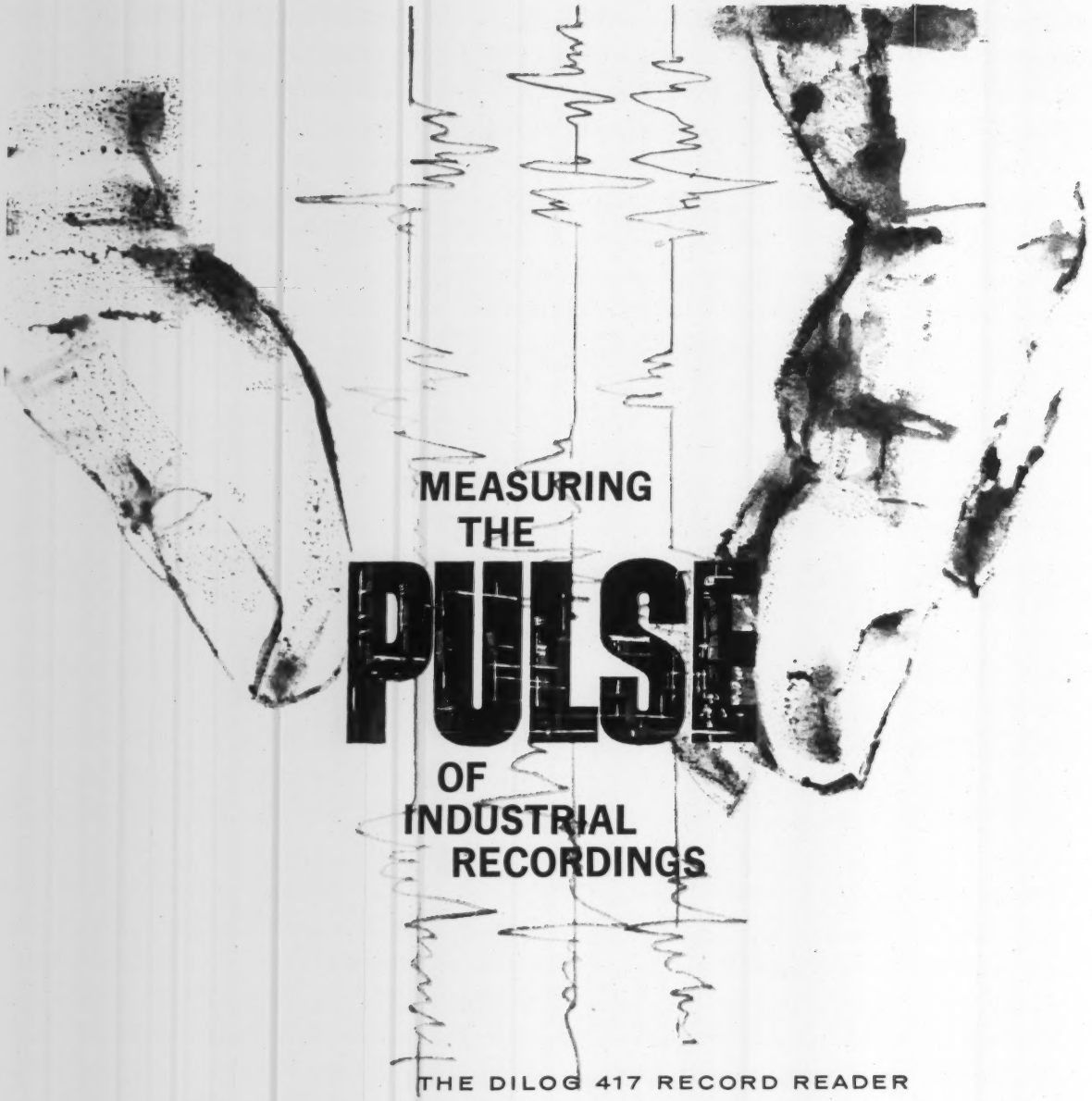
The performance of your servo system will also be improved if you use C.I.C. Carbon Film Pots. Send us your specifications today.

MORE THAN 3 MILLION C.I.C. CARBON FILM POTS HAVE BEEN MANUFACTURED FOR MILITARY AND INDUSTRIAL USE.

C I C COMPUTER INSTRUMENTS CORPORATION

92 Madison Avenue • Hempstead, N. Y.

For more information circle 57 on inquiry card.



MEASURING THE PULSE OF INDUSTRIAL RECORDINGS

THE DILOG 417 RECORD READER

Keeping a finger on the pulse of automatic and semi-automatic data recording systems of modern industrial facilities requires advanced data reduction systems. In the fields of petroleum, chemical, utilities, medical, pharmaceutical, and similar industries —where critical testing techniques demand *accurate* and *immediate* reduction of data...the Data Instruments DILOG 417 Record Reader provides the most economical and efficient method of translating *both* paper and film oscillographic records to useful digital form. The extra-large viewing and measuring area allows quick and accurate translation of data into any desired digital form . . . cards, tape, printed lists.

Pioneers in Instrumentation For Data Analysis

DATA DI INSTRUMENTS

Ask for the complete story of DILOG 417. Write, wire, or phone:

DATA INSTRUMENTS
DIVISION OF TELECOMPUTING CORPORATION
12838 SATICOY ST., NORTH HOLLYWOOD, CALIFORNIA. PHONE: STANLEY 7-8181

For more information circle **58** on inquiry card.

HAGAN NEWSLETTER

Behind the Panel

THE QUALITY OF MEASUREMENT FIXES THE QUALITY OF CONTROL

Control can only be as precise as the measurements on which it is based. Not only the measurement, but also the means by which it is transmitted to the recording or actuating mechanisms must be as near perfection as possible if a high degree of control quality is to be maintained. Here are some examples of how Hagan achieves exact control by means of accurate measurements:

MEASUREMENT SPAN CRITICAL IN REDUCING TEMPERATURE VARIATIONS

A large eastern steel mill was seeking a temperature controller for continuous strip annealing furnaces—a process that threads light gauge, cold rolled steel through the high temperature furnace in the range of 800 ft/min and provides fully recrystallized steel, ductile in spite of its relative hardness, with other desirable physical properties. They set up a Hagan PowrAmp and a competitive controller side by side on two new furnaces. The suppressed range feature of the PowrAmp made possible the holding of temperature variations to 2-3F—its span was set at 1,500 to 1,700F for the test. On the basis of these very acceptable results, which the competitive controller could not match, the PowrAmp was put in control of the temperature on these two lines. Later, when two more annealing lines were added, PowrAmp temperature controllers were selected—resulting in Hagan control of all four annealing lines at the mill.

SOAKING PIT REAL TEST OF METER TURNDOWN RANGE

When ingots start to heat in a soaking pit, maximum fuel firing is required. But later in the cycle, only enough fuel to maintain the desired temperature is needed. This may be less than 10% of max. Hagan Ring Balance gas and air flow meters, calibrated for a maximum differential of 10"WC, are accurate with as little differential as .035"WC, or about 6% of the full scale of the meter. This means that fuel-air ratios are maintained exactly throughout the full soaking pit cycle. Particularly critical when special alloys are being heated, precision ratio control pays off across the board in maintenance of quality and in fuel savings. (Item C-1)

MEASURING STEAM FLOW WITHOUT A PRIMARY ELEMENT SAVES MONEY

High pressure steam flows may be measured without the use of a primary element in applications where the Reynolds number is in excess of 10,000,000. Since the line loss produced through a certain length of pipe cannot be predicted as accurately as with an orifice plate, it is a necessity that the meter connected to measure the loss have an adjustable range to accommodate the unpredictable differential that can be established only after start up. Due to its wide range of adjustment, the Hagan Ring Balance meter makes feasible the accurate measure of steam flow using pipe friction as the source of differential. This eliminates the need for installing a very expensive, high-alloy flow nozzle in the steam line. (Item C-2)

MUST HAGAN HIGH QUALITY BE HIGH COST?

Public Utilities have learned that this is not the case. The utilities are bound by law to select new equipment on the basis of competitive price and comparable quality. Here is the score for the last 58 new boiler control systems awarded as a result of this competitive bidding:

	Successful Bids		Successful Bids
HAGAN	19	Company "C"	3
Company "A"	19	Company "D"	2
Company "B"	13	Company "E"	2

(Item C-3)

HAGAN CHEMICALS & CONTROLS, INC.

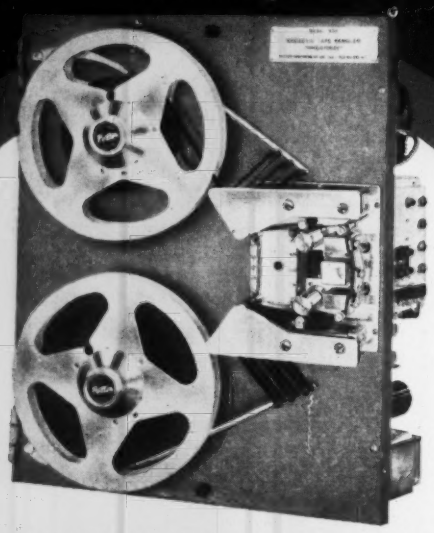
Hagan Building, Room 702, Pittsburgh 30, Pennsylvania
In Canada: Hagan Corporation (Canada) Limited, Toronto
European Division: Via Flumendosa No. 13, Milano, Italy

If you would like more information on any of the above items, check the appropriate box below.

☐ Item C-1 ☐ Item C-2 ☐ Item C-3

For more information on Powr Amp circle **59** on inquiry card.
For more information on Air Flow Meters circle **60** on inquiry card.
For more information on Steam Flow Meters circle **61** on inquiry card.

New Speed...Versatility...Reliability...



TRANSISTORIZED DIGITAL MAGNETIC TAPE HANDLER MODEL 906

• Check these new standards of reliability and performance

- Completely transistorized for maximum reliability
- Trouble free brushless motors
- Over 50,000 passes of tape without signal degradation
- Linear servo system
- Life expectancy of pinchroll mechanism: over 100,000,000 operations
- Skew ± 3 μsec ½" tape, center clock at 100 i.p.s.
- Vacuum loop buffer
- Continuous flutter free cycling 0 to 200 cps
- Normal speed up to 100 i.p.s.
- Rewind or search speed constant at 300 i.p.s.
- Six speeds forward or reverse up to 150 i.p.s.
- Better than 3 milliseconds start, 1.5 millisec. stop
- Front panel accessibility
- In line threading
- End of tape and tape break sensing
- All functions remotely controllable
- Tape widths to 1¼"

The 906 is usually supplied with the Potter 921 transistorized Record-Playback Amplifier; a unit that features:

Pulse or level outputs
Output gating
1 i.p.s. to 150 i.p.s.
Manual, relay, or electronic function switching
Dual read-write operation

Potter also manufactures a complete line of Perforated Tape Readers, High Speed Printers and Record-Playback Heads.

Contact your Potter representative or call or write direct for further information.

See us at the I. R. E. Show—Booths 1912-14

The mark of Engineering Quality

POTTER INSTRUMENT COMPANY, INC.
Sunnyside Boulevard, Plainview, N. Y.
OVerbrook 1-3200

Potter has career opportunities for qualified engineers who like a challenge, and the freedom to meet it.

For more information circle **62** on inquiry card.

events

April 3-4

7th Northwest Conference on Quality Control, Oregon Museum of Science and Industry, Portland, Oregon. For information write ASQC, P. O. Box 2001, Portland 14, Oregon.

April 14-15

Conference on Industrial Instrumentation and Control, Illinois Institute Of Technology, Chicago, Ill. For information write R. W. Bull, Illinois Institute of Technology, 35 West 33rd St., Chicago 16, Ill.

April 16-17

Reliability Symposium, sponsored by Boston Sec., A.S.Q.C., Statler-Hilton Hotel, Boston, Mass. For information write Bob Fabian, Keystone Camera Co., 16 Hallet Sq. Dorchester, Mass.

April 16-18

Eleventh Annual Southwestern I.R.E. Conference and Electronics Show, Dallas Memorial Auditorium, Dallas, Texas. For information write SWIRECO, P. O. Box 7722, Dallas 26, Texas.

April 20-21

Third National Conference on Analog & Digital Instrumentation, Bellevue-Stratford Hotel, Philadelphia, Penna. For information write F. H. Zimmerli, Rohm & Haas Co., 5000 Richmond St., Philadelphia 37, Penna.

April 25-30

41st Annual Meeting of Scientific Apparatus Makers Association, Greenbrier, White Sulphur Springs, West Va. For information write Jim Irving, SAMA, 20 N. Wacker Dr., Chicago 6, Ill.

May 6-8

1959 Electronic Components Conference, IRE, EIA, AIEE and WCEMA, Benjamin Franklin Hotel, Philadelphia, Pa. Write Bernard F. Osbahr Electronic Industries, Chestnut & 56th Sts., Philadelphia 39, Pa.

May 20-22

National Spring Meeting of Society for Experimental Stress Analysis, Sheraton Park Hotel, Washington, D.C. For information write Leonard Mordfin, P. O. Box 4996, Washington 8, D.C.

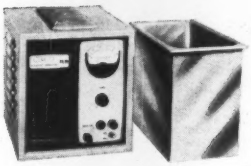
May 21-22

1959 Ohio Valley Instrumentation-Automation Exhibit & Symposium, sponsored by Cincinnati Section ISA. For information contact Richard Surkamp, 8846 Round Hill Rd., Cincinnati 36, Ohio.

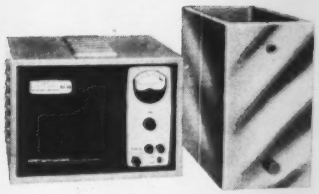
November 16-20

Fifth International Automation Exposition, The New York Trade Show Building, 500 Eighth Ave., New York City. For information write Richard Rimbach Associates, Mgmt., 845 Ridge Ave., Pittsburgh 12, Penna.

CIRCOSONIC®



Model BC 60
Capacity - 1 gal.
output - 60 watts

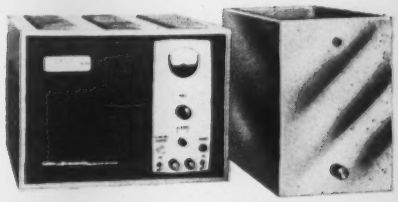


Model BC 125
Capacity - 2 gal.
output - 125 watts

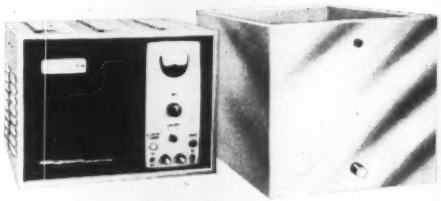
ultrasonic

multi-purpose cleaners

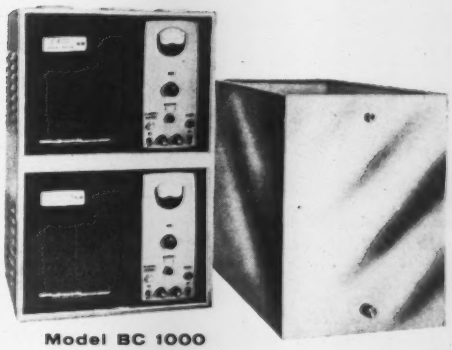
by the most experienced company in the application of ultrasonic energy for metal cleaning



Model BC 250
Capacity - 5 gal.
output - 250 watts



Model BC 500
Capacity - 12 gal.
output - 500 watts



Model BC 1000
Capacity - 25 gal.
output - 1000 watts

THE CIRCOSONIC POWER TRANSDUCER CONCEPT

The magic word "ultrasonics" alone is not enough. To accomplish the results for American industry, sufficient driving **Power** must be applied to a **Precisely Designed Transducer** at the correct **Frequency** — consistently. This concept of **Power** ultrasonics is embodied in **Circosonic.** Only **Circo** meets these requirements, combined with trouble free continuous operation and economical purchase cost.

Solid stainless steel is used in cleaner tank manufacture making them suitable for all type liquids. Controls are conveniently placed and identified for ease of operation by unskilled personnel.

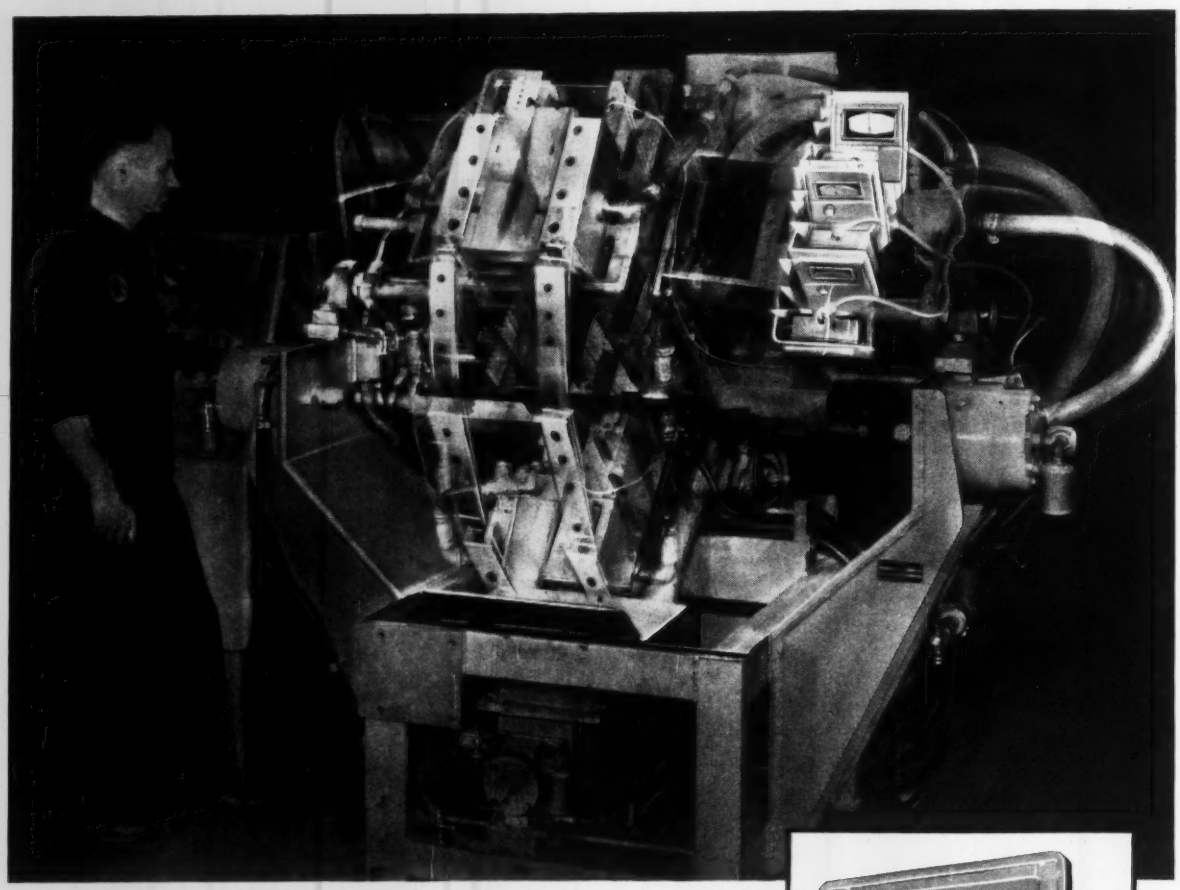
From the first ultrasonic cleaning machine publicly operated at the National Metal Congress at Philadelphia in 1952, to the new BC Series, **Circo** has consistently demonstrated its leadership in the design and application of ultrasonic energy.

Commercial units in operation range from small laboratory models to huge conveyorized automatic units, handling up to 20,000 lbs. metal parts per hour. **Circo** engineers will be pleased to offer technical assistance and recommend specific units to fit your needs.

Send for our new booklet
"Tips on Ultrasonic Cleaning"
For more information circle **63** on inquiry card.

CIRCO *ultrasonic* **CORPORATION**

Specialists in ultrasonic energy
51 TERMINAL AVENUE, CLARK NEW JERSEY



A Partlow Model MFS indicating controller is shown in action in this "multiple exposure" shot of a Holo-Core Automatic Molding Machine manufactured by Spo, Inc., Cleveland, Ohio.

The Temperature Control Built to
SHRUG OFF SHOCK
2438 Times a Day

Every working day, the Partlow Temperature Control in this photo takes between 2400 and 2500 solid "roundhouse punches" from the shell-molding machine to which it is attached.

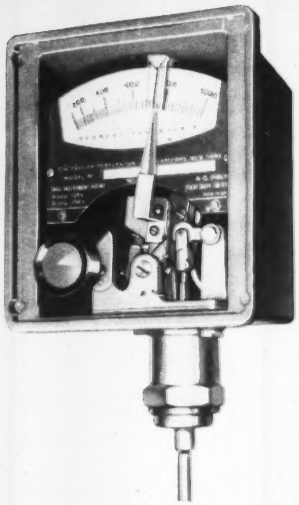
But despite jarring shock and vibration, and a constant barrage of foundry dust, the Partlow goes right on delivering precision control—without letup or breakdown.

Actually, only a control as simple and rock-solid as the Partlow could withstand this kind of punishment! Because only the Partlow contains no hairsprings, or delicate gadgets.

All Partlow thermal elements of the same range are interchangeable *on the job*, too. There's no time lost waiting for your control to come back from the factory. And you get this extra margin of dependability *without loss of accuracy*. Partlow controls are precise to within 1% of scale in any one of 10 ranges from −30° to 1100° F.

If you use or manufacture equipment within this temperature range, there's a Partlow to fit your application exactly . . . and save you money, too. Available in Pneumatic, Electric or Self-Contained Gas types, in recording, indicating or non-indicating models! To field test any Partlow control . . . or to obtain full details write, The Partlow Corporation, New Hartford, N. Y. Dept. IA359.

Export Ad, Auriema, Inc., 85 Broad St. New York 4, N. Y.



A complete absence of gadgets and superfluous parts, as seen in this open view of the new MFS indicating control, explains the Partlow's unique ability to function accurately even under the most severe operating conditions.

You can pay more but you can't buy better than

PARTLOW

TEMPERATURE CONTROLS

For more information circle **64** on inquiry card.

Unique combination of performance, size and price

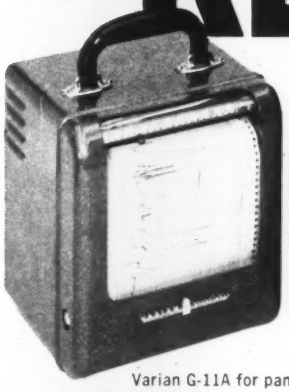
OVER 1000 TIMES AS SENSITIVE as galvanometer recorders. . . and Varian's null-balance potentiometer needs no power from the source being measured. Rugged, stable mechanism allows ink or inkless recording — easy-to-read rectilinear chart — source impedances of up to 100,000 ohms.

LESS THAN HALF AS WIDE as a standard 19-inch rack. Two Varian G-11A's mount side by side on a rack panel 10⅜ inches high. Or as a portable, the G-11A is an easy-to-handle 15 pounds. The G-10 sits on less than one square foot; its horizontal chart is handy for jotting notes.

MORE VERSATILE AND ADAPTABLE than any similar recorder — adjustable zero, adjustable span (from 9 to 100 mv on the G-11A), multiple chart speeds (up to four on the G-11A), and plug-in input chassis for different recording requirements.

VARIAN STRIP CHART RECORDERS

PRICES THAT BEGIN AT $365 for the G-10 and $470 for the G-11A. Because unneeded performance costs money, Varian has intentionally designed for 1% limit of error and 1-second balancing time. Thus, Varian provides needed ruggedness, dependability and operating features at moderate cost.



Varian G-11A for panel, rack or portable use for laboratory or equipment builder.

Varian G-10 bench-top recorder for accessible, horizontal chart.

WRITE TODAY FOR COMPLETE SPECIFICATIONS AND STANDARD OPTIONS

VARIAN associates

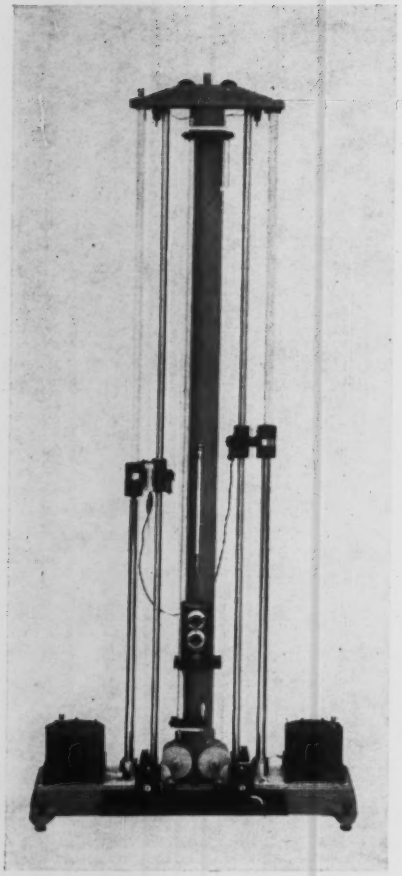
INSTRUMENT DIVISION

PALO ALTO 1, CALIFORNIA

For more information circle **65** on inquiry card.

Exactel Servomanometers...

Exactel Servomanometers offer the highest accuracies that have been attained in commercial pressure and liquid level instruments, combined with more than a dozen operational advantages that have resulted in many new instrumentation techniques, applicable to many diverse fields in physical measurements, including many not ordinarily associated with manometers.



Dual instrument with Analog Temperature Compensation and calibration proving provisions for use as a standard.

"Analog Temperature Compensation," a development of Exactel, provides a breakthrough in the solution of the temperature problem in precision pressure measurement. ATC virtually eliminates the greatest source of error in precision manometers caused by ambient temperature variation or cyclical temperature fluctuations in thermostatically controlled enclosures. The techniques also eliminates cabinet warmup time and the other disadvantages of thermostatically controlled enclosures. The compensation is automatic and continuous.

Optional use of stainless steel manometer tubes, with unimpaired sensitivity and performance, has greatly extended the use of manometers in high pressure systems and instruments of large range.

Any manometer liquid may be used, generally in a single instrument.

The instruments are operational in nature, presenting the output data on a mechanical counter and as a proportional shaft position for digitizing, control, recording, transmitting.

The float operates within the AC field of the differential transformer which induces a vibration of a few micro-inches amplitude. The vibration eliminates float hysteresis and there is considerable evidence that there is improvement of the meniscus form itself. Also, the float responds to the center of the meniscus.

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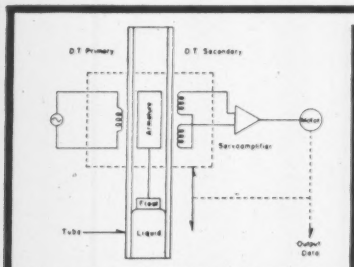
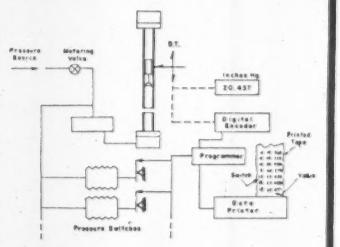


The basic principle...A differential transformer (DT) is continuously positioned by a servo to be electrically centered about a float containing magnetic material. A proportional shaft position in the servo transmission is then analogous to the position of the liquid column.



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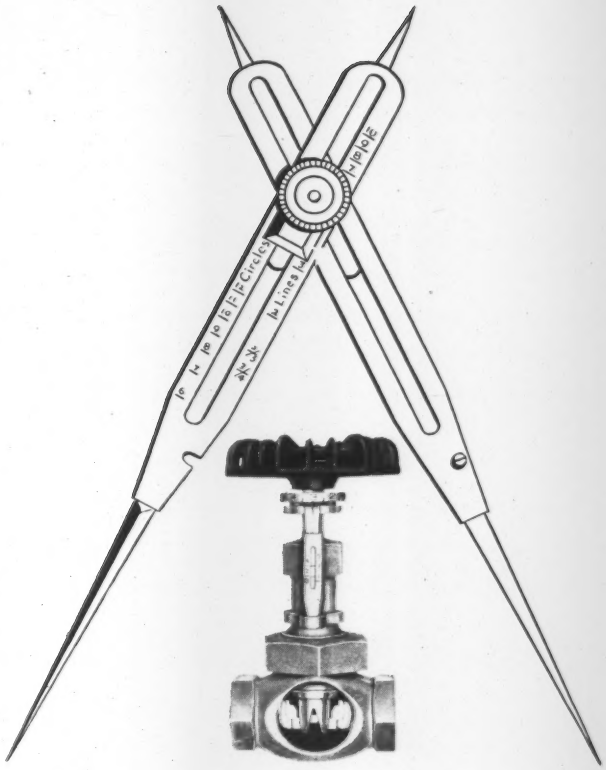

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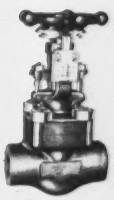

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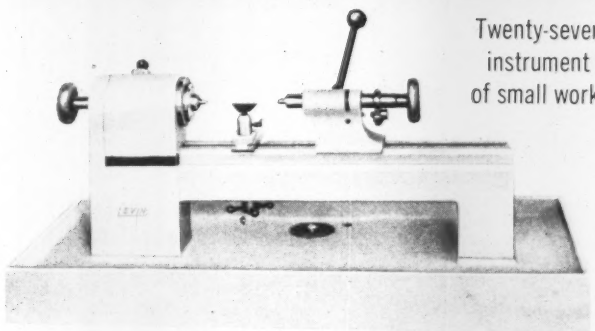

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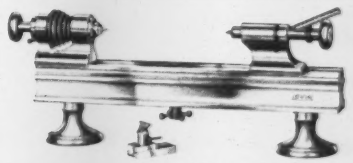

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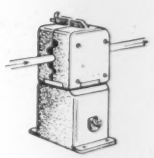

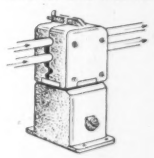

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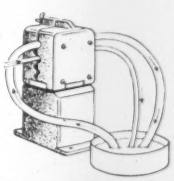

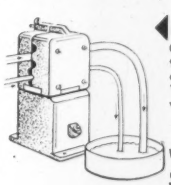

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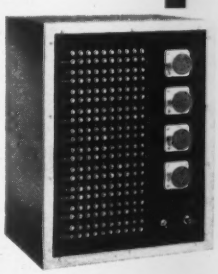

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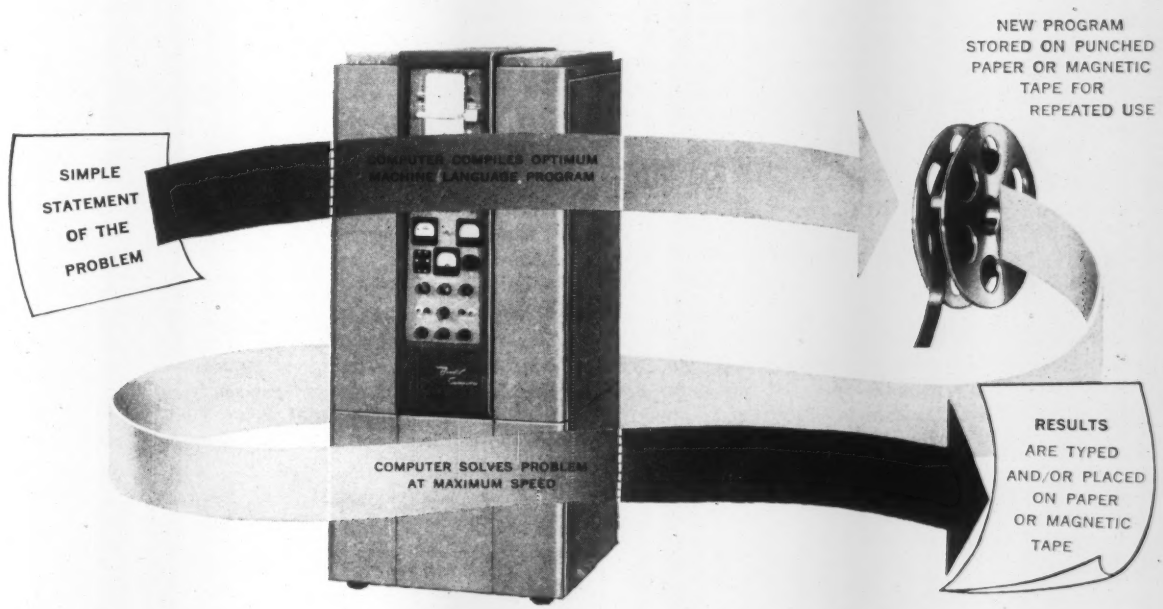
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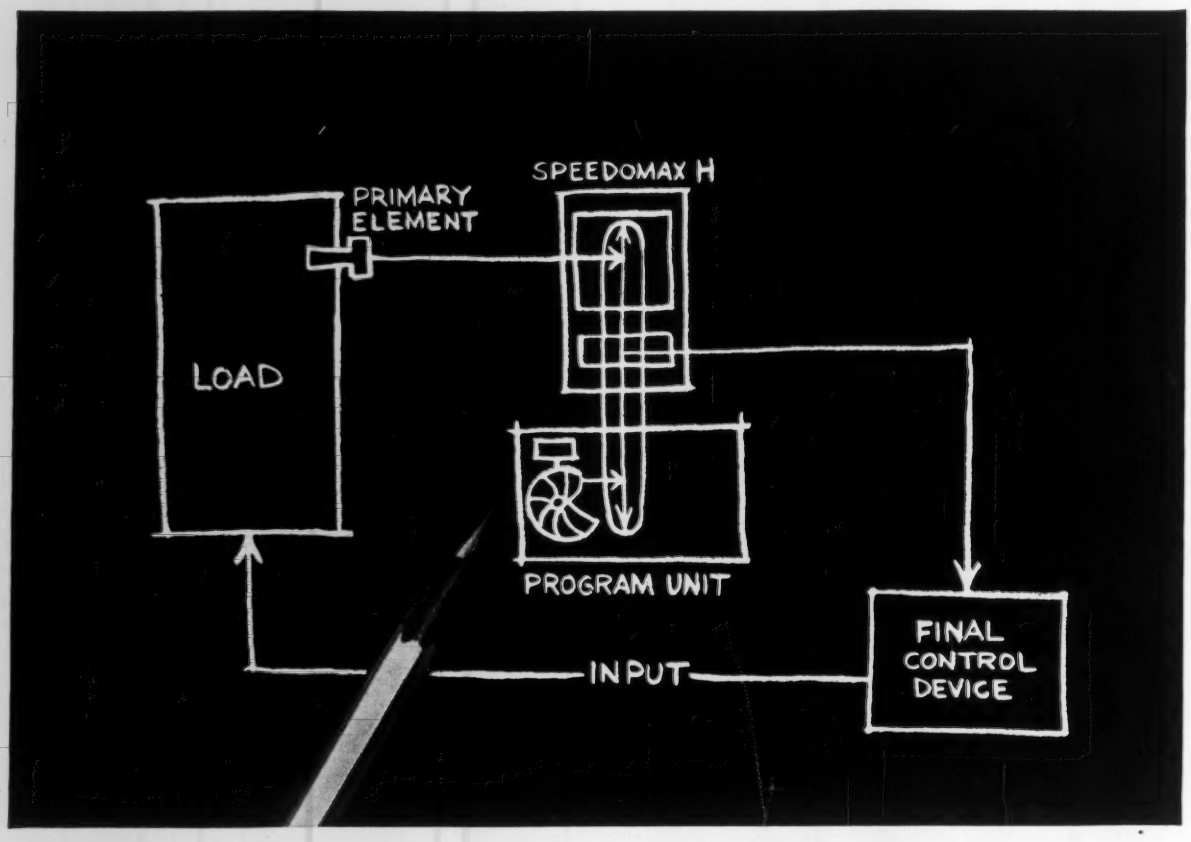

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editorial

Anti-Hardwarism—

A Threat to American Education and the Instrument Industry

Conclusions reached after three years of work with a public high-school system, attempting to upgrade a physics curriculum by introducing instrumentation and electronics.

THE FUTURE of our nation rests absolutely and firmly on its 40,000 public-school systems. This is one of the vital, keynote facts of our time, and the fact that the school systems suffer from serious weaknesses hardly bears repeating.

So much has been written and said about the school systems that most people probably believe that (1) the trouble is known and (2) something is being done about it. But much of what is being done today is not helping most school systems; actually the opposite is true.

Problems of magnitude require two things for solution—(1) support and (2) proper direction. When *both* are available, the problem can be solved completely. But when the leadership leads in the wrong direction, then even the support given to the problem only worsens the situation. This is happening in public-school education today, particularly in the field of technical education.

The success of the Russian technical education system brought the weaknesses of the American counterpart into the open—which public-school officials had been trying to do for years. Typically, a handy scapegoat was immediately beaten almost to death (in this case the school officials themselves) and a group of "experts" was appointed to devise programs to lead the nation out of technical-education wilderness.

Typically also, the experts selected have as little knowledge of the problems of public-school education as any other single group in the nation. But since these experts consider themselves the nation's top authorities in all problems educational, the prognosis for progress is bad; nobody has ever solved the problem of making an expert in one field see his own inexpertness in another.

This is the basic problem in public-school education today. The "expert" is the university group.

This is written to show that the university group is unfamiliar with the problems of *public* school education, and that the result of placing public-school leadership in their hands, combined with the still almost total lack of Federal support for the public-school system, is a potentially fatal combination for progress at the high-school level.

The Essential Difference Between The University and the High School

It has been mentioned that public-school officials have for years been pleading for greater financial support and warning of the consequences of lack of support. This group has been more than aware of the defects in public-school education; it has lived with them. It also has lived with a social status that places "school teachers" in the class of incompetents. Who but an incompetent would work for the pay they get?

The university professor, however, is in a completely different status, if not financially then at least socially. In contrast with the school teacher struggling with long division, he is expounding cosmic theory; the former is a hack, the latter a brain.

However these are *not* the real differences. Both groups actually teach known and simple facts; both are professional in education and subject matter. The basic difference is that whereas the university teacher teaches an adult, the public-school teacher, including the high-school teacher, teaches a youth.

EDITORIAL —CONTINUED

At the university level there is no problem of motivation; the student learns or gets out. If the teacher is no good, the student learns to learn for himself. Most university professors are lecturers, not teachers.

But the high-school teacher cannot afford this luxury; the lecture technique at this level is fatal. Ideally, every student must learn enough to pass into the next grade. The lower intelligences must not be neglected completely in order to stimulate the more intelligent. Each student must learn; he must be motivated; every technique must be used to capture his interest and make him want to learn.

This serious problem for the public-school teacher does not even exist for the university teacher. The result is that the latter has been using fewer and fewer motivating aids and hardware, more and more theory. Today the philosophy of teaching at the college level has been hardened and accepted—as a matter of principle, hardware is not to be used, is to be avoided. Hardware means working *equipments* and *apparatus,* including *instruments,* whether used as a teaching aid or a practical example of a principle at work.

It should not be overlooked that there is a good practical reason for this philosophy. Hardware is expensive and difficult to keep in working order and up to date. A theoretical subject is not only cheaper but more respectable. This attractive combination has led to a firmly established university philosophy: The college teaches "science, not technique; it teaches theory, not practice; it teaches ideas, not hardware." This philosophy is perfectly appropriate for the university for obvious reasons—it is economic and respectable, and the lack of motivation is no problem.

But it is just this lack of motivation that makes this philosophy unworkable as a teaching philosophy at the high-school level, where motivation is as important as content, where motivation *must* be used to stimulate the student into learning and advancing. This stimulation and motivation means hardware, technique, actual practice—the very items that the university rejects as a matter of principle. Thus we have a situation today where a teaching technique which is essential at the public-school level has become heresy at the university level.

Effects of the Anti-Hardware Philosophy

The anti-hardware philosophy of the university has been accepted so completely that it is a bias, despite some obviously ridiculous conclusions that have resulted from it. The extent to which an erroneous philosophy can keep otherwise intelligent persons wedded to obvious fallacies is truly remarkable. The following are but a few examples:

Dean J. D. Ryder, the Dean of Michigan State University, says, "To join science with hardware results in the training of technicians, which is not the objective of the university." The mental roadblock is obvious. The anti-hardware philosophy has blinded this man to the obvious fact that modern scientific apparatus is scientific, and that it can be used effectively to teach science.

Dean Ryder also states in one of his editorials in the *Proceedings of the Institute of Radio Engineers* (December, 1958): " . . . many of our departments have made advances in removing the hardware and are attacking the subject at a high science level." Note that the elimination of hardware (instruments and apparatus) is now an advance; the anti-hardware philosophy requires an attack on hardware even where it is in use.

Dean W. L. Everitt of the University of Illinois, Chairman of the powerful Engineers' Council for Professional Development, says, "If one is to build in college on high-school physics, I do not see how . . . electronics can ever fit into the picture." Here again the mental roadblock is obvious. This man with a national reputation in electronics cannot see how electronics can stimulate and enrich and motivate a physics curriculum, which it obviously can.

Referring to a high-school program* that is using hardware Dean Everitt continues, "Such training is helpful in the production of technicians, but it does not fit into a professional engineering program." The training to which he was referring includes the principles and operation of nuclear instruments, laboratory standardizing equipment, infrared and mass spectrometers, and other equipments which could only be called highly academic by any open-minded scientist or engineer. But once the anti-hardware decision has been made, the mind is no longer open; an infrared spectrometer becomes a shovel.

The FIER Says Instrumentation Is Only For Technicians

To show the extent to which this can happen, let us refer to the Foundation for Instrument Education & Research, a foundation *supported financially by the entire instrument industry* for the basic purpose of promoting the teaching of instrumentation at all levels. Logically, when a group of sixty high-school senior students in Pittsburgh volunteered to study instrumentation and electronics and other areas of modern physics, the Foundation was approached for financial help. The Foundation rejected any help of any kind on the basis, "there is a place in the technical high school for an introduction, much less extensive than this, to instruments, for boys and girls who want to be technicians . . . a course of this kind is not proper for top-level science talent."

Here we have a group denying its own reason for existence. Instruments are suitable only for technicians; the scientist, even the budding one, must be guarded against instruments.

*See "Report on Public High-School Course in Modern Engineering Physics," *INSTRUMENTS & CONTROL SYSTEMS,* Feb., 1959.

The instrument industry should be greatly interested in the anti-instrument philosophy of its Foundation for "Instrument Education" and Research. Students wishing to study instrumentation can get no help from the instrument industry because of its own Foundation.

Let us refer again to the group of high-school seniors in Pittsburgh who are studying instrumentation and electronics.

This program is sponsored by *fourteen* technical societies in the Pittsburgh area, who volunteer expert lecturers and provide modern apparatus, on loan, for the students to see and study. Surprisingly, an active opposition to this program developed from several society groups. In each instance the opposition stemmed from university professors in those groups, who apparently saw in this program a threat to their educational anti-hardware philosophy, or perhaps to themselves. Can it be that a student who knows instrumentation is a threat to a professor who doesn't?

Specifically, a professor on the electrical engineering staff of the University of Pittsburgh was instrumental in keeping the Pittsburgh Chapter of the American Institute of Electrical Engineers from assisting these high-school students with the *fundamentals of electrical measurements!* Another professor (in the Society for Experimental Stress Analysis) was instrumental in keeping the Pittsburgh Chapter of the SESA from helping these same high-school students with the *fundamentals of strain-gage instrumentation!* To what extent will "academic purists" work against their own best interests (which in this case is also the interest of the instrument industry) because of the prevalent anti-hardware philosophy?

Where Is All The Money and Effort Going?

If opposition to a program designed to upgrade a physics curriculum via instrumentation comes from university groups, what progress can be expected when university groups are put in charge of designing programs for upgrading the high-school curricula? We can look at what we do get, since university groups always are selected to suggest and direct such programs.

One of the things we get is a "Visiting Scientist Program in Physics" sponsored by the National Science Foundation, in which 100 prominent physicists are paid to visit high schools and colleges and chat with physics teachers. (Cost: Hundreds of thousands of dollars to date. Results: Some nice chats.)

Another thing you get is a high-school physics curriculum designed by the Massachusetts Institute of Technology (and supported by *several* national foundations) wherein the high-school professor is urged to use toothpicks, bamboo rods, and wood blocks to illustrate the principles of physics. Toothpicks are "academic"; an actual instrument is "vocational." (Cost of this course has been several *millions* of dollars to date. Results: Lots of wood blocks.)

Another thing you get is "advanced standing courses." These are simply college-level courses given at the high-school level, and those High-School Superintendents who can boast of an advanced-standing program are proud indeed. But since the high-school problem is a weak basic high-school course and a weak preparation for college, how does a college-level course given in the high-school help? It helps just like the addition of another story on top of a building with a rotten foundation; it puts greater strain on the foundation and assures an earlier collapse. But the advanced-standing program is suggested immediately by any university group called in to help the high-school—and it always is.

Still another thing you get is a 3-week intensive course in Theory of Instrumentation and Automatic Control, for technical institute teachers, given at Case Institute and sponsored by the Foundation For Instrument Education & Research. This 3-week intensive course (a contradiction in terms) included operational mathematics, Nyquist criteria, non-linear analysis and analog computers—for teachers who probably don't know a standardizing potentiometer from a filled thermal system!

(We digress for a moment to suggest that the instrument industry look at its books long enough to discover that it is still the "instrument industry," that it makes every penny it earns from its instrument sales, and that the huge red-ink loss sums spent on "systems" and "dynamics" are possible only because of its instruments. We suggest that the industry remind the Foundation for Instrument Education, etc., that its first allegiance is to the instrument—not to a basically anti-instrument philosophy.)

Each month now sees the announcement of more "academically pure" courses, each of which expends tens of thousands of dollars without teaching any practical, useful instrumentation.

The Pittsburgh Program

In contrast to these expensive programs, the Pittsburgh Modern Physics program referred to previously did the following on a $20,000 budget (including outfitting of a laboratory from benches to oscilloscopes): It developed an integrated, year-long course in many phases of modern physics, with more than $250,000 of loaned modern apparatus, plus more than 50 visiting expert lecturers on various phases of physics. Yet the course remained at all times under the direction of an experienced high-school physics teacher. It combined the best of conventional teaching plus lecturing plus laboratory plus demonstration technique—and in the several areas of modern physics. Of the 56 students who took this program in its first year, 41 are now in college. *This* is the program that encountered university and FIER opposition as being too "vocational."

According to teacher, students, and scores of supporters, the Pittsburgh program, now in its second year, is succeeding beyond all hopes in teaching modern engineering physics via its instrumentation. And

it is doing this despite university opposition (which has blocked the path to the millions in funds tied up in government-supported foundations such as the National Science Foundation), and despite FIER opposition (which has blocked the path to instrument-industry funds). But despite this complete lack of support, the Pittsburgh class continues to teach practical instrumentation.

The Unsung and Unhonored Heroes

If there are unknown villians in this story, there also are unsung heroes. The citizens of our country are blessed with a group of broadminded and intellectually superior men who run their public-school systems more efficiently and with fewer rewards than can be described. For example, in the Modern Physics program mentioned, public-school curricula directors permitted others to revise and experiment with their curricula; vocational personnel worked at developing an academic program; academic personnel worked in developing what many said was a "vocational" approach. It is difficult to describe the selfless manner in which these men cooperated in the new curriculum; it was exactly opposite to the many petty reactions encountered at the university and foundation level.

This discussion has centered on a philosophical debate involving "professionalism." Perhaps it should end on the note that the high-school student is not interested in philosophy or professionalism; he just wants to learn. If everybody involved would forget professionalism and philosophy and vocationalism, and simply do the best job with the best tools on hand, the student will learn much and rapidly. Some of these best tools are hardware, particularly modern instruments.

The Value of Any Instrument Program Should Be Judged In Terms of its Instrumentation

This is an appeal to all technical societies and instrument companies to examine the Modern Engineering Physics curriculum*, with its basic electronics and instrumentation approach, with an open mind. This is an appeal to other communities* to start a program that includes instrumentation. This is an appeal to all local technical societies in every area where this is done to cooperate in the program and do the best job with the best tools at hand. Finally, this is an appeal to the Foundation For Instrument Education & Research to support these basic instrument education activities in Pittsburgh and elsewhere, and to judge the value of such programs on the number and types of *instruments* that are involved.

*See "Report on Public-High-School Course in Modern Engineering Physics," Feb. *INSTRUMENTS & CONTROL SYSTEMS*, for details.

Russian Instruments and American Schools

THE Wednesday, February 11 issue of the *Pittsburgh Sun-Telegraph* newspaper editorializes on the recent availability of cheap Russian instruments for education purposes as follows:

> "If the cheery hail-fellow salesmanship of Comrade Anastas Mikoyan impressed Americans as a classic example of unmitigated gall, here's specific case of Russia business methods that rubs it in.
>
> "The Russians displayed at a recent New York trade show a line of scientific equipment for use in schools. This they are willing to sell at prices so low as to bear no relation to cost of manufacture.
>
> "This . . . . is an attempt to infiltrate American school rooms with Russian propaganda."

We answered the editor of this paper as follows:

In your Wednesday issue you discuss the subject of Russian scientific equipment being made available to American schools. Quite properly, you mention the propaganda value of these instruments.

They have another value—an educational value. Modern apparatus makes a science course stimulating and exciting, showing how scientific principles are put to use.

A school equipped with modern instruments is a step ahead of one that isn't. Hence the Russians are doing us a favor in equipping our schools with inexpensive modern instruments. The only alternative that is good for our country is to supply them with American instruments—but this means Federal aid to education in large amounts.

In the absence of effective Federal aid to education, local programs must be used. Right here in Pittsburgh, the technical community, acting through its technical societies, has organized a high-school course in Modern Engineering Physics, emphasizing Instrumentation and Electronics. More than $250,000 worth of modern scientific apparatus is loaned to the students by local industry, and local scientists lecture on physics while demonstrating these beautiful equipments.

This program is now in its second year, and has been successful in teaching the modern new technologies—digital techniques, servomechanisms, recorders, nucleonics, etc. But even this effort is hampered by lack of funds. For example, if only $4000 were made available, this course could be given to 20 high-school physics and science teachers, thus introducing them to the new technologies. But no source for even this small sum has been found.

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AC VOLTAGE INSTRUMENTATION developed through Cubic Corporation's years-ahead engineering know-how, today guarantees unsurpassed standards of performance. The Cubic AC Converter, available in both manual and automatic ranging models, changes AC input voltages to filtered DC to be read by the Voltmeter and displayed in clear, ultra-brilliant numerals. Full-wave rectification in the Converter assures extreme accuracy over a wide frequency range. High negative feedback provides maximum linearity and stability. The use of vacuum tubes in the Cubic AC Converter is the design feature responsible for high output voltage capability, high input impedance, excellent gain stability, low noise characteristics, protection from the danger of brief overloads. The Converter controls the AC symbol and decimal point, providing direct readout. Precision built, the Converter is accurate, rugged, reliable — another superior Cubic instrument.

CUBIC DIGITAL SYSTEMS can be developed easily to fit any requirement, with unit construction featuring inter-*case* wiring and standard-size plug-in units. Every Cubic system is "customized" through standard construction. Cubic instruments — Voltmeters, AC Converters, Scanners, Pre-Amplifiers, Printer Control Units and Ratiometers — can be combined as "building blocks" to produce digital systems of "Cubic-customized" versatility.

SPECIFICATIONS

AC CONVERTER

Ranging: Manual, automatic or remotely programmed

Input: Range	Input Impedance
.0001 to .9999	1 meg, 25uufd
1.000 to 9.999	10 meg, 15uufd
10.00 to 99.99	10 meg, 15uufd
100.0 to 999.9	10 meg, 15uufd

Accuracy: ± .1% and two digits on all ranges

Linearity: .01% Stability: .02%

Frequency range: 30-20,000 cps

Typical balance time: 7 seconds (Manual Ranging Model AC-1)

Size: Standard unit, 17"x3½"x11⅜". 19" rack fittings, accessories provided.

Model AC-1: Manual ranging; front panel switch

Model AC-2: Automatic ranging; front panel switch selects DC, AC, Automatic, four AC ranges.

Power: All AC instrumentation units are powered by Control Unit C-1.

DC VOLTMETER

Display: 4 or 5 digits

Absolute accuracy (RMS sum of system tolerances): ± .012% and one digit

Bridge linearity: .003%

Attenuator accuracy: .003% per decade

Input filter: Attenuation starts at 10 cps, increases 24 db/octave

Input terminals: Front panel and rear connector panel

Input impedance: DC, at balance, 10 megohms

Bridge resistance: 50,000 ohms

Balance time: Achieved at rate of 30 steps per second:

Model V-41: Typical, 1 second.

Model V-51: Typical, 1.5 seconds.

Output: Contact closures provided for external readout and recording devices

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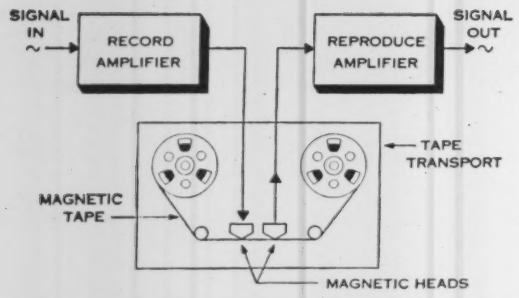


FIG. 1. ELEMENTS of a magnetic tape recorder.

Magnetic

PAUL J. WEBER
Ampex Corporation

MAGNETIC TAPE RECORDING is done by applying a magnetizing force (H) to a magnetic material called magnetic tape (fine iron-oxide particles coated on a nonmagnetic film). The actual signal on the tape is in the form of permanent remanent magnetization after the tape is pulled away from the source of the magnetizing force.

The signal can be recorded directly (direct recording) or it can be converted before recording into frequency variations (FM) or pulse variations (PDM or digital recording) which are then recorded. When such encoding techniques are used, decoding devices must be used in the reproduction process.

The electronic encoding and decoding devices are a part of the record and reproduce amplifiers which, respectively, prepare the input information for recording on the tape, and then recover it from the tape for playback in its original form. The four different recording techniques—direct, FM, PDM, and digital—require different encoding and decoding devices. The requirements for a digital tape transport also are different from those for a direct or direct/FM/PDM transport. These distinctions are discussed elsewhere in this issue.

The Magnetic Head

The magnetic head is the transducer which converts the encoded electrical signal into a signal on the tape (or the tape signal into an electrical signal). A high degree of mechanical and electrical uniformity between heads is essential (1) to allow multiple-track recorded tape to be interchanged from machine to machine without mechanical alignment or adjustment, (2) to permit amplifiers to be substituted one for the other and connected interchangeably from track to track without matching or tuning, and (3) to permit any tape track to be used for any one of the four basic recording processes.

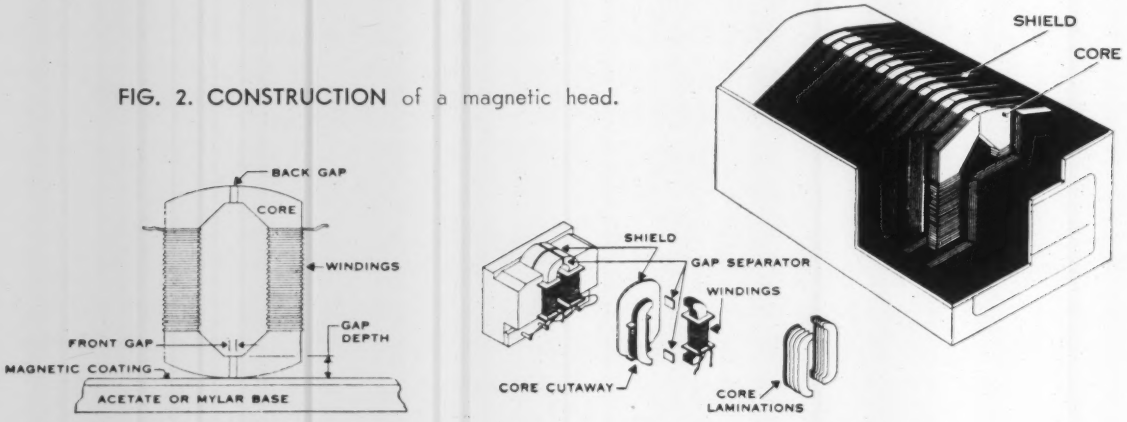
The function of the head is to translate an electric current in the coil into a proportional magnetic field across the gap, or vice versa. Typical magnetic head construction is shown in Fig. 2.

Two identical core halves are built up of thin laminations of a material having high magnetic permeability, low electrical resistivity (for minimum eddy-current losses), and good wear properties (for long head life). Each core half is wound with an identical number of turns, and the halves are assembled with non-magnetic separators for the front and back gaps. Only the front gap contacts the tape and actually enters into the recording or reproduction process; the rear gap maintains the magnetic symmetry of the core halves and minimizes the effect of random hum pickup in the two windings.

Recording Principle

Fig. 3 shows the typical relation between the magnetizing force (H) applied to that portion of the tape

FIG. 2. CONSTRUCTION of a magnetic head.



Tape Recorders

A magnetic tape recorder comprises (1) electronic encoding and decoding devices, (2) magnetic heads, and (3) a tape transport. These three elements, when used in conjunction with magnetic tape, make up a magnetic tape recording system.

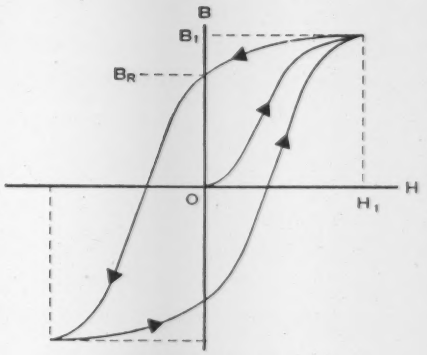


FIG. 3. MAGNETIZATION curve.

under the recording head gap and the consequent magnetization of the tape (B), starting at 0 with a neutral tape. H is proportional to the number of turns on the recording-head winding and the recording current through that winding. If this value is H_1 at the instant a given portion of tape is passing out of the recording gap, the magnetization at that part of the tape will be B_1 while it is still in the gap. As the segment of tape passes beyond the head field, *remanent magnetization* falls to B_R. This is the actual signal on the tape. Therefore, the actual recording takes place at the *trailing edge of the head gap.*

Magnetic tape, like other magnetic material, is characterized by a nonlinear relationship (Fig. 4) between the strength of the field applied and the remanent permanent magnetization which results. However, "low distortion" recording systems can be built by using a bias which causes the signal to remain on only the linear portions of the characteristic curve.

If the signal being recorded is sinusoidal, the magnetization intensity will vary sinusoidally along the length of the tape. Thus a wavelength of recorded signal (λ) will occur for each complete alteration of the input electrical signal, the wavelength being directly proportional to tape speed, and inversely proportional to signal-current frequency ($\lambda = v/f$, where $\lambda =$ wavelength in inches, $v =$ tape speed in inches per second, and $f =$ signal frequency in cycles per second). The wavelength on the tape (in inches) must not be smaller than the gap of the reproduce head or no signal will be reproduced, as will be explained.

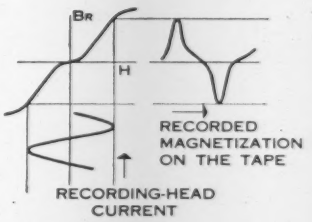


FIG. 4. RECORDING characteristic of the oxide coating.

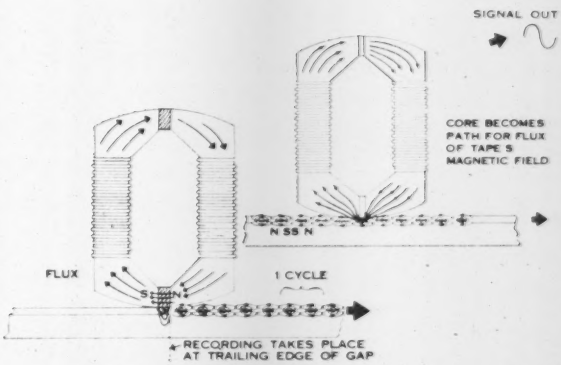


FIG. 5. RECORD HEAD flux (left) aligns tape oxide magnetically; reproduce head (right) completes flux path when magnetized tape moves.

Reproducing Principle

During playback, the magnetized surface of the tape passes a reproduce-head gap (Fig. 5). That portion of tape in contact with the gap at any given instant is bridged by the magnetic core of the head, and magnetic lines of flux flow through the core. The degree of flux is a function of the *average state of magnetization* on that portion of tape actually spanned by the gap at the given instant. As the tape travels past the gap, the amount of core flux varies with *rate of change of magnetization* on the tape and so causes a voltage to be generated in the winding linking the core. This voltage is not proportional to the magni-

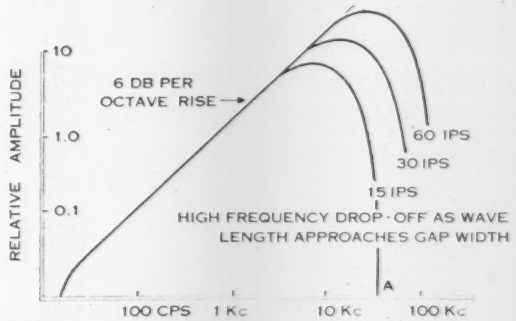


FIG. 6. REPRODUCE-HEAD output characteristic. Output drops rapidly as wavelength approaches gap width.

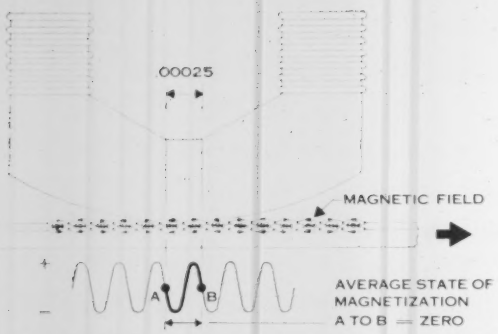


FIG. 7. REPRODUCE-HEAD gap effect at high frequency.

tude of the flux—but to its *rate of change*. In other words, if flux (Φ) is proportional to the recording current:

$$\Phi = Ki = K \sin (2\pi ft)$$

At any tape speed the playback voltage (e) from the reproduce head is proportional to $d\Phi/dt$, or:

$$e = K' \frac{d\Phi}{dt} = K' \frac{d}{dt}(K \sin 2\pi ft)$$
$$= K'' f \cos (2\pi ft)$$

Note that e is proportional to f. This means that at any given tape speed, the playback *voltage* with constant-current recording (recording current constant at all frequencies) varies in direct proportion to frequency, as shown in Fig. 6. In other words, if a 1-kc and a 2-kc signal of equal amplitudes are on the tape, the 2-kc output signal from the reproduce head will be larger than the 1-kc signal.

Fig. 6 also demonstrates that as we go lower in frequency, the reproduce head output voltage approaches the inherent noise level of the system. This is the *low-frequency limit* of the system.

The *upper frequency limit* is imposed by the gap width of the reproduce head (Fig. 7). Note that when the length of a wave approaches the width of the gap, the *average magnetization* in the gap at that time is zero, and hence the output of the head is zero. This condition is shown at A in Fig. 6.

High-frequency response can be improved by (1) reducing the size of the reproduce gap or (2) increasing the tape speed while recording, which increases the wavelength on the tape. Either of these two alternatives, however, involves a compromise in other desirable characteristics: If the gap size is reduced, the voltage output from the reproduce head is lower for all frequencies; the result is deterioration in dynamic range, or signal-to-noise ratio. When tape speed is increased, head wear is increased and less information can be recorded on a given length of tape.

Optimum head design is a compromise between these mutually conflicting parameters, and the following values are commonly used: Tape speed up to 60″/sec; gap width, 0.00025″; resulting frequency response in direct recording, 100,000 cps at 60″/sec tape speed (equivalent to 1600 sine-wave cycles per inch of tape).

Difference Between Record Head and Reproduce Head

The differing characteristics of the record and reproduce heads require separate heads, one built to record, one to reproduce.

A record-head gap must be large enough to achieve deep flux penetration into the tape, and short enough to obtain sharp gradients of high-frequency bias flux at the trailing edge. A compromise value of gap width is one-half mil (0.0005″). The current-carrying capacity of the record-head winding (determined by wire size) and the number of turns must give sufficient *ampere turns* to provide the necessary density of magnetic field flux for effective recording.

By contrast, the reproduce-head windings carry very little current. As the output from the reproduce head is a direct function of the number of turns, it is generally advisable to use as many turns as possible. This dictates using the finest wire which can be handled safely and yet give reliable service.

Heads for Multi-Track Recording

Multi-track recording requires *standards of track width* and *track spacing*. In establishing such standards, the following mutually conflicting factors must be considered: (1) maximum use of the tape, which would indicate narrow tracks closely spaced, (2) good signal-to-noise characteristics, which would make wide tracks for maximum signal output desirable, (3) minimum crosstalk between tracks, which would indicate generous spacing between tracks. Optimum resolution of these opposing factors is found in the standards shown in Fig. 8—a track width of 50 mils, and center-to-center track spacing *on the tape* of 70 mils.

However, to achieve adequate separation between head units in a stack (heads placed at 70-mil spacing are too close and cross coupling might result), two precisely positioned head stacks are used as shown in Figs. 8 and 9. The center-to-center spacing between head units in each stack is 140 mils, and electromagnetic and electrostatic shielding between units is accomplished by alternating layers of Mu-metal and copper between units. This system of having a given head stack serve only alternate tracks on a tape permits the recording of seven tracks on ½″ tape, and 14 tracks on 1″ tape, while holding crosstalk below the inherent noise level of the system.

The use of separate stacks introduces another problem. The two stacks are precisely positioned in relation to each other so that the distance between the lines passing through the centers of the gaps in each stack is exactly 1.500″ ± 0.001″. This determines the *relative timing accuracy* between the information channels recorded on the individual channels. This time-position relationship is also affected by temperature- or humidity-induced tape stretch or shrinkage. Assembling a multi-track head also dictates extremely close mechanical tolerances on gap scatter and gap azimuth angle (Fig. 10). Gap scatter contributes to interchannel timing errors; the deviation of gap azimuth angle from 90° causes deterioration of high-frequency response.

Tape Transport

A tape transport is shown in a simplified form in Fig. 11. Essential components include:

(1) *Supply Reel* to feed out tape and provide a hold-back tension to insure intimate contact of the tape with the magnetic heads. The reel is fitted with a motor for tape rewinding and a brake for decelerating the tape rapidly and smoothly when the transport stops. Hold-back tension is derived from energizing the rewind motor in the opposing direction, by braking, or by both.

(2) *Inertia Roller*, connected to a flywheel, to smooth out variations in tape speed.

(3) *Capstan* to move the tape at a constant linear velocity by means of a constant-speed synchronous motor. Tape is held against the driving capstan by a solenoid-operated spring-loaded capstan idler.

(4) *Take-up Tension Arm* which is spring-loaded to offset the momentary slack occuring between the time the tape motion starts and the take-up reel starts to rotate. The arm also stops broken tape.

(5) *Take-up Reel* to take up tape during operation, and to provide for fast tape shuttling. It is equipped with a motor and a brake for fast deceleration.

There are many refinements and variations of the above basic components, and they are largely devoted to satisfying the most important single consideration in a tape transport for direct, FM, or PDM recording* —maintaining a highly constant speed of tape across the magnetic heads. To maintain a timing accuracy of ¼% in a recording made on one machine and played back on another requires that speed be held to a ⅛% maximum error tolerance on both recorders. This makes the capstan the most critical element because it drives the tape. Any eccentricity or run-out of the capstan, or of the pulleys connecting the drive motor of the capstan, introduces a corresponding periodic variation in tape speed.

Speed errors can be introduced also by variations in tape tension from full to empty reel and by uneven winding of the tape on the reels. Positive control over this tension is exercised by a tape-tension-sensing arm connected to a simple mechanical servo system working on the hold-back brake.

Magnetic Tape

Magnetic tape consists of finely ground iron-oxide particles distributed in a coating on the tape base. The base can be cellulose acetate, polyvinyl chloride, or a polyester. Cellulose triacetate film has also been used, but the most popular instrumentation tape now has Mylar**, a polyester, as a foundation because of its superior mechanical properties, uniformity and inertness to humidity. Common thicknesses are 0.0015″ and 0.001″, which permit winding 2500′ and 3600′, respectively, on a 10½″-diameter reel; ¼″, ½″, and 1″ tape are most commonly used for instrumentation work; Videotape***, which is used for TV recording, is 2″ wide.

*Digital transports require fast start/stop time as the major design consideration.

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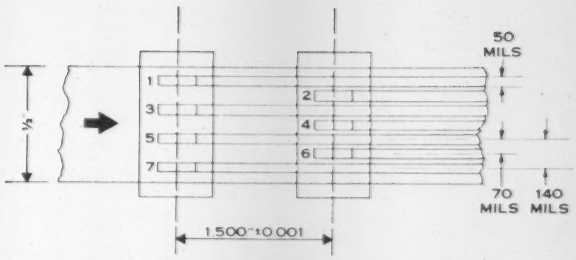


FIG. 8. STANDARDS for track and heads.

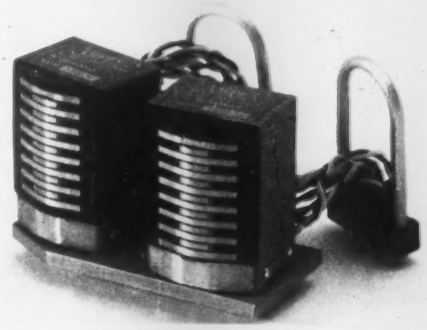


FIG. 9. FOURTEEN-TRACK recording-head assembly comprises two 7-head stacks with 1.5" displacement between stack centerlines. Note full-width shielding between heads.

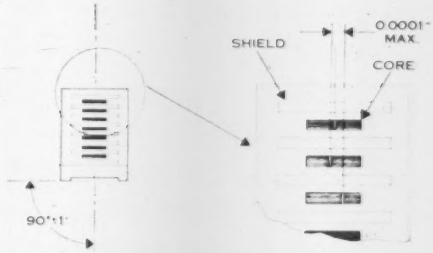


FIG. 10. GAP SCATTER (right) is dimensional offset of gaps on one stack; gap-azimuth angle is shown at left.

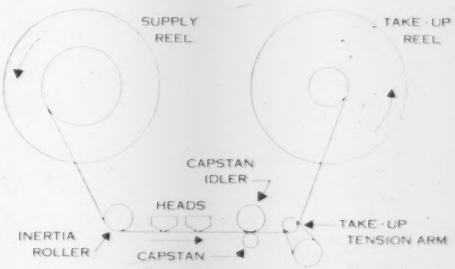


FIG. 11. SIMPLIFIED tape transport.

Recording Techniques

The most popular recording techniques are (1) direct recording, (2) frequency-modulation recording, (3) pulse-duration-modulation recording, and (4) digital recording. These techniques are described.

D. W. HALFHILL
Ampex Corp.

DIRECT ANALOG RECORDING is the familiar process used in the recording of speech and music. It also can be used for recording instrument signals or data. This is the simplest of all recording processes and usually requires one tape track for each signal channel.

Fig. 1 shows the basic tape recording characteristic —that is, remanent magnetism versus applied magnetic field. If the signal to be recorded is mixed with a high-frequency bias it is possible to record the signal completely within the straight-line portions of the recording characteristic, as shown in Fig. 1.

The bias and recorded signals are combined by a linear mixing process—that is, the signals are mixed in a linear mixer, but not in a nonlinear modulator. This type of mixing is not amplitude-modulation (in which new sum and difference frequencies would be generated) but is a simple mixing. The bias frequency is usually at least 3.5 times the highest signal frequency to be recorded. As the recorded wavelengths of the high-frequency bias are too small to be resolved by the playback head (Fig. 2), the bias frequency is not picked up from the tape—its function is only to insure that the recorded signal remains on the linear portion of the characteristic.

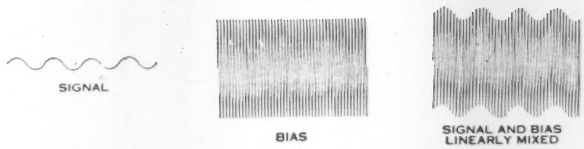
The output voltage of the reproduce head is proportional to the frequency of the signal because the head output is a function of rate-of-change of magnetization. Therefore, the reproduce (decoding) amplifier must have a frequency-response characteristic which is the inverse of the reproduce head characteristic to obtain an over-all flat frequency response. This is referred to as *playback equalization* (Fig. 3).

When signal frequencies are so low that the resulting reproduce head signal output approaches the system noise it is impossible to recover the signal by equalization. This accounts for the principal limitation of direct recording, the lower frequency limit, below which it is impossible to play back successfully. The upper frequency limit is reached where the wavelength on the tape approaches the gap width. This is a function of recording tape speed, as shown in Fig. 4.

The high-frequency end (100 kc at 60″/sec) has

TABLE 1—COMPARISON OF RECORDING PROCESSES

Process	Low-Frequency Limit	High-Frequency Limit	Effect of 1% change in tape speed	Figure of Merit (cycles/inch)	Channels per track	Advantages
Direct 60″/sec 30″/sec 15″/sec	 50 cps 50 cps 50 cps	 100 kc 50 kc 25 kc	1%	1600	Usually one; several with tone multiplexing	35-db dynamic range; overloads gracefully with gradual distortion; simplest; widest frequency response.
FM wide deviation	0 cps	10 kc at 60″/sec	2.5% error	167	One on wide band; up to 18 on one track with narrow-deviation (7.5%) FM	Good to zero frequency; relatively insensitive to tape dropout; good resolution of transients; permits changes in time base; good linearity.
FM narrow deviation	0 cps	Depends on deviation	13% error at 7.5% deviation	167		
PDM	0 cps	Limited by sampling rate up to 5 cps nominal.	1%	40	UP to 86 channels, time multiplexed	Good to zero frequency; less sensitive to flutter than FM; up to 86 channels per track with accuracy better than 1%.
Digital	0 cps	Limited by sampling rate and code used.	None	5—NRZ 2½—RZ	Usually one; can be time multiplexed	Highest accuracy recording in computer language; insensitive to flutter and wow. Simple circuitry; output can go directly to computers.



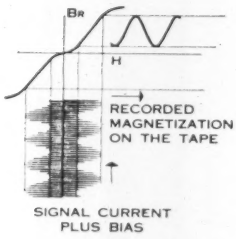


FIG. 1. SIGNAL AND BIAS are first mixed. Envelope of resultant signal falls only on linear portion of recording characteristic.

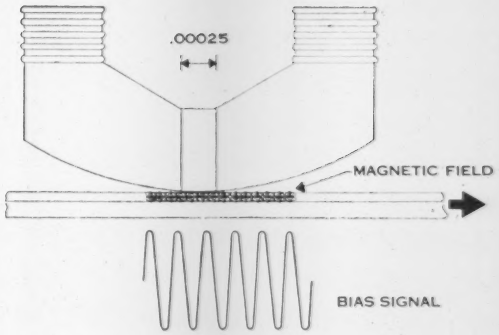


FIG. 2. WAVELENGTH of bias frequency on tape is too short to be resolved by reproduce head.

FIG. 3. REPRODUCE amplifier delivers flat output because of "playback equalization" of reproduce-head output.

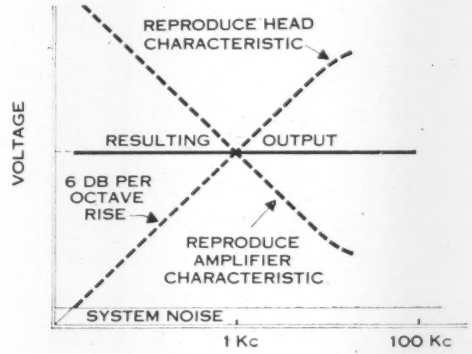
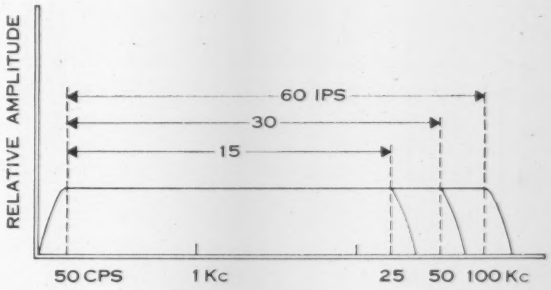


FIG. 4. OVER-ALL frequency response, direct recording, at three tape speeds.



Disadvantages	Applications	Tape Requirements
Audio recorder not suitable for instrumentation; dropout effect serious for instrumentation (not for audio); won't record to 0 cps due to noise.	Audio (with equalization); spectrum analysis of noise and underwater sound; recording any a-m signal with frequency components between 50 cps and 100 kc.	Dropout affects higher frequency signals.
Complex circuitry; severe transport requirements because flutter causes serious error. Tape is used less efficiently than in direct recording.	Shock blasts; explosion; any signals with components from 0 to 10 kc; radio telemetry.	High squareness tape characteristic; low d-c modulation noise; smooth surface.
Limited freq. resp.; complex equipment and circuitry; low tape utilization.	Many channels with low-frequency signals, such as flight and engine testing.	Least demanding of all tape methods.
Poor tape economy; data must be digitized; very sensitive to dropout—requires computer-quality tape and checks for lost or spurious data.	Computers; accounting; numerical applications; processing of flight test and wind tunnel data.	Most demanding because drop-out means an error. NRZ requires tape squareness characteristic; low d-c modulation noise.

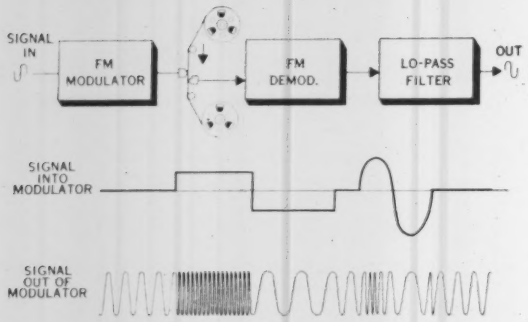


FIG. 5. FM OPERATION. Low-pass filter at output rejects carrier frequency and passes only desired signal.

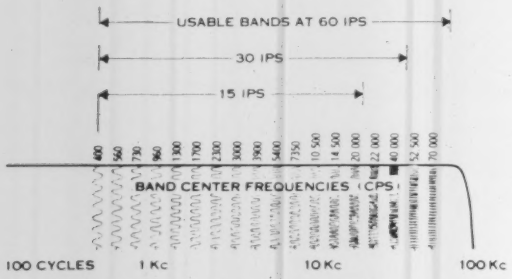


FIG. 6. NARROW-DEVIATION FM is used in frequency multiplexing.

1600 cycles per inch of tape, which can be taken as a figure of merit for direct recording and used to compare with other tape recording systems (Table 1).

Audio Recorders

An ordinary audio recorder should not be used for instrumentation recording because the energy content in speech and music signals is not uniformly distributed over the range of signal frequencies and the recording amplifier pre-emphasizes the extreme low and high ends of the frequency spectrum. Thus, when an audio recorder is used for instrumentation, the built-in pre-emphasis distorts the high and low frequencies. This could be overcome by reducing the recording level by a considerable amount, with resulting deterioration of the signal-to-noise ratio.

Frequency-Modulation Recording

Frequency modulation overcomes the two basic limitations or direct recording—inability to record low frequencies and amplitude instability caused by tape dropouts. A particular frequency, selected as the center frequency, corresponds to zero input signal. A d-c signal causes the carrier frequency to vary in one direction; an a-c input signal causes the carrier frequency to vary on both sides of center frequency (Fig. 5). Thus, all information presented to the tape is preserved in the frequency domain and normal amplitude instabilities have little or no effect on the recording.

On playback, the signal is demodulated and fed through a low-pass filter which removes the carrier and other unwanted frequencies generated in the modulation process.

Two FM-carrier systems are in use—wide deviation and narrow deviation.

A widespread application of the latter is in frequency-division multiplexing (Fig. 6). Here a number of individual carrier frequencies are each modulated by a separate input signal. The result is a multitude of signals which are mixed linearly. The composite signal can be reduced on one track using the direct reading process. Thus, the wide bandwidth and linearity of direct recording permits simultaneous recording of many channels of signal information on one track of tape.

Flutter and Wow

FM recording makes stringent demands on the ability of the tape transport to move tape at uniform speed. Any speed variations cause an unwanted modulation of the carrier frequency, causing system noise. This is the limiting factor in the dynamic range and accuracy of FM.

This limitation is particularly acute in the frequency-multiplex scheme (Fig. 6) because a 7.5% frequency deviation usually corresponds to 100% input signal. Hence a 1% deviation in frequency resulting from flutter appears as a noise signal of $100/7.5 = 13.3\%$. Similarly, any speed variation in the transport is multiplied by a factor of 13.3

Wide-deviation FM has a wider dynamic range and greater over-all accuracy. Here only one channel of signal is recorded on a track of tape and the entire bandwith is used for this signal (Fig. 7). Hence a deviation of $\pm 40\%$ of carrier frequency is possible. In this case a 1% tape-speed error causes only a $100/40 = 2.5\%$ noise signal, an improvement of better than five times that of the narrow-deviation system.

While it is possible to record data down to dc at any tape speed, the upper-frequency recording limit varies directly with tape travel, going to 10 kc at 60″/sec with standard output filters. This gives a figure of merit of 167 sine-wave cycles per inch of tape, but the upper frequency limit is much higher than those offered by other recording processes which will record dc. The center-carrier frequency varies with tape speed and is usually chosen about midway in the frequency band dictated by this speed. Thus, with wide-deviation FM recording, where a 60″/sec tape movement offers a carrier frequency range from 100 cps through 100 kc, the center-carrier frequency is usually around 54 kc. At 1⅞″/sec the center carrier frequency is 1.7 kc, midway in the range between 100 cps and 3125 cps. At any tape speed, the highest data signal frequency to be recorded is approximately 1/5 the center-carrier frequency.

Time Base Change

If it is not necessary to record frequencies as high as 10 kc, the tape speed can be reduced in direct proportion to the desired upper-frequency limit. When this is done, the center frequency is scaled down in direct

proportion to the tape speed, using the same ±40% deviation used in wide-band FM-carrier technique. Thus, the wavelength recorded on the tape corresponding to a given d-c signal voltage is the same, independent of tape speed. This makes it possible to record at one tape speed and reproduce at an entirely different tape speed, permitting time base changes, up or down, one of the important applications of FM recording. Note that the maximum ratio between standard record and playback speeds is 1:32 (ratio of 1⅞ to 60 inches per second).

Pulse Duration Modulation

The basic techniques of direct and FM recording have been described.

The third basic technique is PDM, or pulse-duration modulation, wherein the duration of a pulse is made proportional to the amplitude of the signal to be recorded. This technique is used commonly with commutation to multiplex a large number of channels. This is called *time-division multiplexing* and requires sampling a number of signal channels sequentially.

For example, the signals shown in Fig. 8 can be sampled at uniformly spaced discrete intervals, recording only the instantaneous values at the time of sampling. The original waveform can be reconstructed on playback by passing the discontinuous readings through an appropriate filter. An accurate reproduction of a sine wave can be made using as few as six samples per sinewave cycle. The sampling rate should be at least six times the highest significant frequency-component.

It is possible to space the intervals and use the time between for sampling other data channels by a commutator which samples the outputs of a number of transducers in sequence (Fig. 9).

Two contacts on the commutator are reserved usually for frame reference to allow synchronization with the commutator used on playback. Two other contacts can be used for calibration signals, one for full-scale and the other for zero signal. Thus, the system permits calibration once each revolution. The remaining contacts are connected to the outputs of various transducers.

The signal from the commutator (point A in Fig. 9) is a sequence of short-duration pulses of varying amplitude (Fig. 10, A).

As magnetic tape cannot record these varying-amplitude signals accurately and dependably, the signals are passed through a keyer which converts them from varying-amplitude signals into constant-amplitude signals of varying pulse width, or pulse duration (Fig. 10, B). Pulse durations normally run from 90 microseconds (for zero signal) to 660 microseconds (for 5-volt full-scale signal).

The only significant information in the signals from the keyer is the time each pulse begins and ends. The record amplifier (encoder) differentiates these pulses and presents the record head a positive spike for the beginning of a pulse and a negative spike at the end of a pulse (Fig. 10, C). Constant tape speed is important but flutter and wow is less critical because only the speed error between the instant of pulse

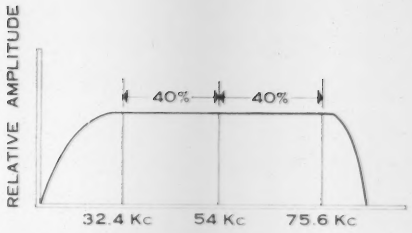


FIG. 7. WIDE-DEVIATION FM carrier bandwidth at 60"/sec tape speed.

FIG. 8. TIME-DIVISION multiplexing by signal sampling. Time between samples of a given signal is used to sample other signals.

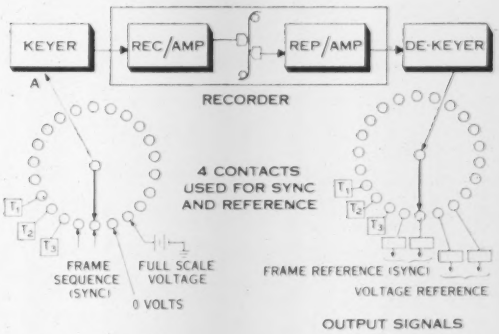


FIG. 9. MULTIPLEX PDM recording technique.

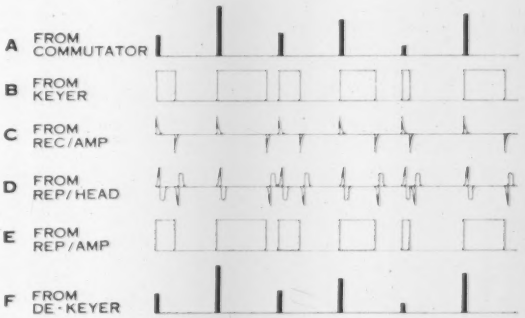


FIG. 10. SIGNAL shapes at various points in PDM.

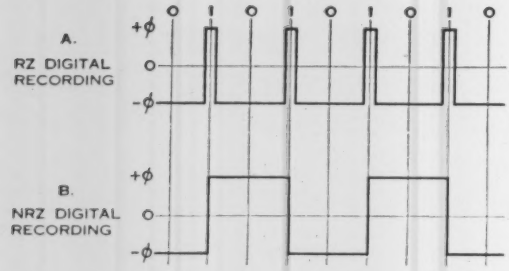


FIG. 11. TAPE magnetization in RZ and NRZ digital recording.

start and pulse stop causes error in recorded data.

Output from the reproduce head is, as in all magnetic-tape systems, a differentiation of the recorded signal (Fig. 10, D). The instant the reproduced wave crosses the axis can represent pulse start and stop. The reproduce amplifier (decoder) contains a multivibrator which recreates the varying-duration pulses (Fig. 10, E). These pulses are then fed through a dekeyer where they are converted back into varying-amplitude pulses of short duration (Fig. 10, F). This is decommutated and the separate data channels sent to individual filters that reconstruct the original data signals.

The chief advantage of PDM is its ability to record many signal channels at better than 1% accuracy overall. One track can carry 86 channels using a 10-rps 90-contact commutator.

Digital Recording

The fourth basic recording technique is digital. Digital recording is accomplished by magnetizing the tape to saturation in either of the two possible directions. The change in direction takes place at precise intervals along the length. Either of two techniques are commonly employed for recording—RZ and NRZ.

A. *Return-to-Zero (RZ).* In return-to-zero recording, one state of saturation (+) represents the binary digit one (1) and the opposite state (—) represents the digit zero (0). However, after each "1", the tape returns immediately to its "0" magnetization state. Thus the digital number 010101010 would result in a magnetization along the track as shown in Fig. 11A. Note that tape magnetization always returns to its saturation direction signifying binary zero—not zero magnetization—immediately after each binary one has been recorded. Nowhere is the tape left unsaturated in digital recording.

B. *Non-Return-To Zero (NRZ).* In the non-return-to-zero method the direction of magnetization is reversed each time the binary digit 1 is recorded; it remains unchanged when recording the digit 0 (Fig. 11B). NRZ is the more efficient recording method because it permits twice the number of digits to be recorded for the same number of pulses (reversals) and permits higher pulse-packing density on the tape. This is seen from Fig. 11; in RZ recording there are twice as many magnetization reversals as in NRZ.

Relative timing accuracy is a problem of greatest importance in digital recording because the digits (or bits) making up a given number or character are recorded simultaneously, in parallel across the tape, with each bit on a different track. Obviously the pulse-packing density must not be too great because the closer the pulses, the more the possibility of errors due to tape skew, dropouts, head scatter, etc.

Interleaving tracks, such as are used for multiple-channel direct or FM recording, are unsuitable for digital recording because of the resulting deterioration of relative timing accuracy due to positioning tolerance between the two stacks. However, as the dynamic range and crosstalk requirements are less severe in digital recording, closer track and head spacing can be used. Thus heads for digital recording can be stacked sixteen in one inch (62 mils apart).

Dropout, Redundancy and Parity Check

Digital recording is sensitive to tape dropout errors; lost or spurious pulses cannot be tolerated. For this reason special precautions are taken in the manufacture, inspection and selection of tape intended for digital recording. Even this does not solve the problem completely.

Safeguards can be built into the digital recording process to provide greater reliability against tape dropouts or other errors. One of these is the use of redundancy technique, in which the same information is recorded twice.

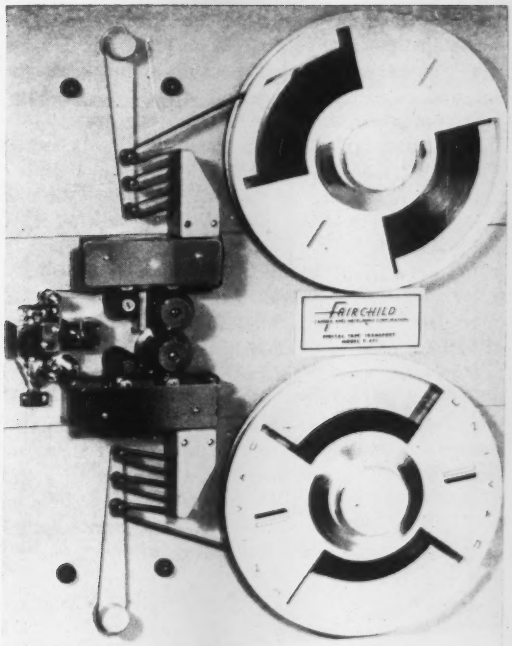
A second scheme is the use of a parity check, in which one track on the tape is reserved for a pulse which is derived from the pulse being recorded simultaneously on the other tracks. A parity pulse is of such polarity that the sum of all bits on playback (including the parity bit) will be an odd number. Thus an error will be indicated if one pulse (or any odd number of pulses) is lost. Parity checking will not detect two simultaneous errors or any even number of errors.

Tape dropouts become most critical at short wavelengths—where the pulse duration approaches the size of the gap in the reproduce head. This demands the use of moderately long pulses on the tape, reducing the pulse packing density. The limitations imposed by dropout and tape skew have resulted in an accepted conservative pulse-packing density of 200 pulses per inch for reliable digital recording. As 7 bits equal one word or sample, and as six samples are required per cycle, 200 pulses per inch are the equivalent of about 5 cycles per inch of tape:

$$\frac{200 \text{ bits/inch}}{(6 \text{ samples/cycle})\ (7 \text{ bits/sample})} = 5 \text{ cycles/inch}$$

Thus the figure of merit is low (Table 1) and it is customary to edit the data while still in analog form to determine those portions of the data which have significance. This is sometimes done using quick-look graphic techniques. The selected data are converted to digital form and recorded for further refinement and computation.

The digital magnetic tape recorder has characteristics that are very different from those of the analog recorder.



THE DIGITAL MAGNETIC TAPE RECORDER

C. KEZER
Fairchild Camera & Instrument Corp.

THE TWO general types of data recorders are:

1. Analog (Direct, FM, PDM)
2. Digital (RZ and NRZ)

Both are descended from audio magnetic tape recorders; although superficially similar, they have widely diverging characteristics.

Present tape transports of both types are widely used in multiple-track versions having from 1 to 25 tracks on tapes ¼″ to 1¼″ wide. Speeds up to 150″/sec are used.

Analog Recorders

Analog recorders are generally characterized by (1) low distortion, (2) high signal-to-noise ratio, (3) flat frequency response, and (4) smoothness of tape motion (low wow and flutter). Starting and stopping times of the tape are only secondary in importance, and are in the order of seconds. Crosstalk, or the interaction between adjacent tracks, is often important, and must be kept low for best signal-to-noise ratio. A-c recording bias normally is used in direct audio recording.

Digital Recorders

In digital recording, most of the above requirements are secondary to the need for *rapid start-stop operation*, and start-stop times of less than 5 milliseconds are common. (Compared to seconds in analog recorders).

Usually, a binary-coded digit or alpha-numeric character is recorded in parallel, with 4 or 6 bits across the tape. Presence of a flux *change* indicates a "one."

Another track, called the "clock" or "sprocket" track is often used. It is fully recorded with "ones" marking each frame. Still another track is sometimes used for "block markers" or checking purposes. Hence the typical digital recorder will have up to 8 parallel tracks, all of which can be simultaneously written (or read).

Reading and writing are not normally done at the same time in a digital recorder; hence a single read-write head can be used for both purposes.

An erase head, commonly found on analog recorders, is sometimes used on digital recorders. However, present practice generally is to dispense with it, as the method of writing maintains the tape in saturation and is self-erasing.

Information is normally written on the tape in *blocks*, commonly 120 characters long, although blocks may be of any length. Since pulse density is usually 100-200 characters per inch, a block generally occupies an inch or less of tape.

Inter-block gaps are left during writing to allow room for the tape transport to start and stop during the reading operation. Thus intermittent reading and writing can be done at the discretion of the computer, one or more blocks at a time. It is seen that a transport requiring long gaps for starting and stopping would

use more tape for gaps than for the record. Hence start-stop time becomes a critical parameter. In addition, computer time might be wasted during acceleration and deceleration.

Start-stop *distance* is even more significant to the digital transport user that start-stop time. Start distance is the amount of tape that is consumed while the transport is coming up to speed; similarly stop distance is the length of tape which flows after a stop command has been given. A typical commercial tape transport running at 75″/sec will stop in 0.25″ to 0.35″; starting distances are slightly less. At slower tape speeds, start-stop times remain the same, and the distance are correspondingly reduced.

Distortion (which is critical in analog recorders) is unimportant in digital because only the presence or absence of a recorded pulse in a given track constitutes the data. Normally the tape is maintained at magnetic saturation during writing (the usual term for the digital recording process) at all times except during the writing of a one (1) bit—when current in a track is reversed to produce saturation of the tape in the opposite direction.

Signal-to-noise ratio need not be high; tape characteristics limit this to about 14 db.

Low *wow and flutter* is desirable, but need not approach that of a good-quality analog tape transport.

Frequency response has little significance. Pulse repetition rate depends on the number of pulses packed per inch of tape (pulse density) and the tape speed. Pulse densities of 200 per inch are now considered conservative; present trend is to higher pulses densities.

Crosstalk is tolerated more easily in digital recording because the level of crosstalk in modern recording heads is well below the level of d-c modulation noise.

Skew is the over-all time variance revealed by reproducing pulses that were written simultaneously. Skew has constant and fluctuating components; it is produced by both electrical and mechanical sources. Differences in delay in reading and writing amplifiers and in head inductance produce *electrical skew. Mechanical skew* results from disturbances in tape motion arising from tape slitting tolerances, and mechanical misalignment of tape rollers and guide posts with the heads. Low skew is mandatory in a digital transport because skew is one of the principal factors limiting the pulse-packing density.

Magnetic Tape Dropouts

Dropouts are not a function of tape alone. Neglected factors include head and transport factors. Dropout indexes should include the entire system.

ERNEST FRANCK
Reeves Soundcraft Corp.

DIGITAL TAPE SYSTEMS easily record 200 pulses per inch on each magnetic tape track. A ½″ tape with 7 tracks will thus have 1400 pulses/inch. equivalent to 2800 pulses per square inch of tape. A ½″ x 2500′ reel of tape holds 40 million impulses.

A typewritten page with solid l's would have only 4000 characters, (50 lines of 80 l's per page.)—less than a 3″ length of tape in capacity. Hence it would take 10,000 pages (20 lbs) of paper to have the capacity of one 2500′ reel of ½″ tape. Yet the small reel of tape must store these 10,000 pages of characters and play them back without a single error. One of the principal problems which had to be solved to achieve this degree of reliability was the elimination of dropouts.

Despite all reasonable precautions in manufacturing, the surface of tape is not completely smooth and homogeneous; surface defects of various types occur. The most serious of these are the "nodules" or clusters of oxide particles which protrude above the surface of the tape. In passing across the recording head, these bumps push the tape away from the head (Fig. 1) and cause a drop in signal level. The same thing happens if a particle of dirt happens to be on the tape as it passes under the head. The effect is more serious with high-frequency signals because the shorter wavelengths approach the size of the nodules or foreign particles and the signal is lost completely. This *dropout effect* is relatively unimportant for audio recording because the ear tends to integrate variations in signal level if they occur instantaneously. With instrumentation and digital recording, however, such loss of signal is intolerable.

Dropouts in digital work are said to occur whenever a recorded pulse fails to be reproduced with sufficient amplitude. In typical equipment this thresh-

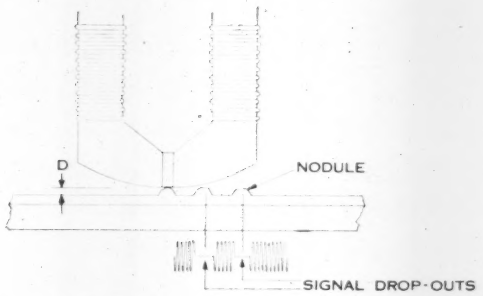


FIG. 1. NODULE can cause dropout over an area larger than that of the nodule itself.

hold amplitude will be well below 25% of the normal average amplitude.

Tape manufacturers have dropout testing systems where the entire area of the tape is recorded (over 40 million separate impulses on a single ½" x 2500' reel of tape). The tape is played back and a count is made of all pulses which do not reach a predetermined gate amplitude. This gate amplitude is usually set to a level much higher than a typical tape system requires for reliable operation, making the test condition more severe than the use condition requires.

Manufacturers generally give numerical tolerances in specifications for dropouts *as measured on their own particular test system*. The track widths and packing density used have been spelled out in these specifications, but other details of the tape test equipment have not been described as carefully. The result has been the mistaken notion that track widths, pulse density, and tape perfection are the only factors which affect dropouts in a tape system. This is far from true; the *tape transport* itself can affect tape dropouts.

For example, reel flanges must be sturdy and true. If a reel flange is bent so that the edges of the tape rub it, some small chips will be knocked off the tape and wound in between layers. These chips can remain partially embedded in the coating, particularly if the tape has relatively soft coating, and will cause trouble every time the tape is run.

Other contributing factors include head curvature, area of contact with the head, and angle at which the tape approaches and leaves the heads. These are generally referred to as *head geometry*. Contact of tape and head at the edge channels is particularly sensitive. Weave in the tape, grooves worn into the head, and damaged tape edges due to rubbing on reel flanges, all can affect the edge channel.

Nodule Effect

If a small nodule on the tape surface passes over the head, a ring-shaped area of the tape surrounding the nodule will be separated from the head. This area will be much larger than the nodule. This is why a tiny surface defect on the tape too small to see can result in an area of tape tenfold or more larger being rendered inoperative.

If the separated area happens to be in the space between tracks, tape contact in the track areas need not be affected. Similarly with a wide track, say 0.050", the nodule may be located near one edge and not have any effect at all at the other edge, whereas if the track width were only half as much, the entire track width would be affected.

The halo-shaped area of separation that surrounds a nodule will depend on the tape tension. If we pull the tape tighter the halo will shrink in size; if we reduce the tape tension the halo will enlarge. The effective tension perpendicular to the tape can be regarded as the pressure which forces the tape towards the head. For a fixed tape tension, this effective unit pressure will be higher for a smaller radius of head curvature, higher for a smaller area of contact, and higher for greater angles of approach and departure. All these things have to do with how much a particular defect in tape surface will affect the system performance. Note that a tiny nodule is much worse than a tiny hole in the tape coating. The tiny hole affects the tape only over its own area, the nodule affects the tape for many times more than its own area. Thus polishing to remove nodules is important.

Deposits

Some tape coatings form gummy deposits on the head surfaces. These must be cleaned off with cleaning fluid. A portion of this deposit can form close to the head slits and effectively separate the tape from the head, resulting in low playback levels. This is worse at elevated temperatures and at higher tape speeds. Ideally, a tape surface should not generate any wear products which are gummy because the gumminess permits small pieces to accumulate in a sticky mass.

One method suggested for combatting this gumminess is use of a thin protective coating applied over the magnetic coating. This has the basic disadvantage of separating the magnetic coating from the head surfaces by the thickness of the protective layer; hence this layer must be kept as thin as possible.

Another method of combatting gumminess is use of a magnetic coating made to have a dry and powdery end product which can't accumulate on head surfaces.

Conclusion

As better and better tapes are used on better transports to do more things faster, it will be helpful if dropouts are regarded as a property of the system, rather than of the tape alone. In order to assign a dropout index with a meaningful numerical value, we must use *identical test systems*, not merely identical tape.

Magnetic Tape System for Analog,

Versatility of modern tape system is evident from this 7-track magnetic tape recorder/reproducer system. It handles analog, PDM, and FM signals, and is designed for use where high-speed acquisition of large amounts of precise data is required, as in telemetering, wind tunnels, and engine test stands.

PRIMARY DESIGN FEATURES of the Type 5-752 DataTape are an accuracy of 0.15% peak-to-peak cumulative wow and flutter for frequencies from d-c to 5 kc; interchangeable analog, PDM and FM operation; and mechanical simplicity and reliability. Designed for 7-track ½" tape, or 14-track, 1" tape, and 14" reels, it is easily converted to 2-track ¼" tape or 28-track 1¼" tape.

Performance figures on the 7-channel system at a speed of 60 ips include analog frequency response of 300-100 kc; FM response of 0-10 kc.

Recording speeds are available from 60 ips to 1⅞" per second in electrically selectable pairs. Precision reels up to 14" in diameter can be used, allowing uninterrupted recording and playback for a full 16 minutes at 60 ips with a 1 ½-mil instrumentation tape.

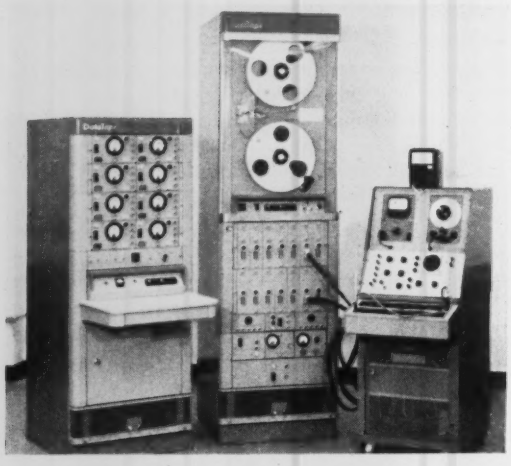


FIG. 1. MAGNETIC TAPE Recorder/Reproducer Type 5-752 (center) with test cart (right) and mixer console (left) built to customer specifications to monitor input signals.

All inputs and outputs can be continuously and remotely monitored from a rack termination panel.

Fast forward and rewind of a 14" reel of 1½-mil tape requires less than 5 minutes.

The system will work in ambient temperatures from +5 to 50°C; relative humidity of 100%; barometric pressure from 30" to 20.6" Hg; coastal regions or sea transport or tropics.

Block diagram of the system is shown in Fig. 2. All of the blocks for a complete 7-channel system are mounted in a single cabinet (Fig. 1).

A remote control feature prevents the machine from being started unless there is more than 300' of tape on the supply reel, the tape has been threaded correctly, the follower arms are in operating position, and the cut-off arm is in its normal position. "Ready-to-operate" is indicated by a light at the machine and at remote locations.

An automatic transfer circuit is provided for continuity of recording. When the tape on the supply reel reaches a predetermined minimum, or if the tape should break during recording, the operation is immediately transferred to a standby machine.

A precision speed-sensing roller run by the tape measures when the reel has brought the tape up to the required speed, and energizes the pinch roller actuator to press the tape against the rotating capstan. Thus the tape speed control is transferred to the capstan without inducing starting stresses in the tape. The tape is brought to stable operating conditions at any speed in less than two seconds after push-button operation.

Amplifiers

Each amplifier has provisions for monitoring the inputs and outputs remotely. This monitoring is dc, it is isolated from sensitive circuits to eliminate interaction, and is of a low impedance to allow monitoring at distances. Amplifier adjustments (compensation, bias level, monitoring, etc.) can be made with a screwdriver while operating.

PDM, or FM

KEN FETTY
Datatape Division
Consolidated Electrodynamics Corp.

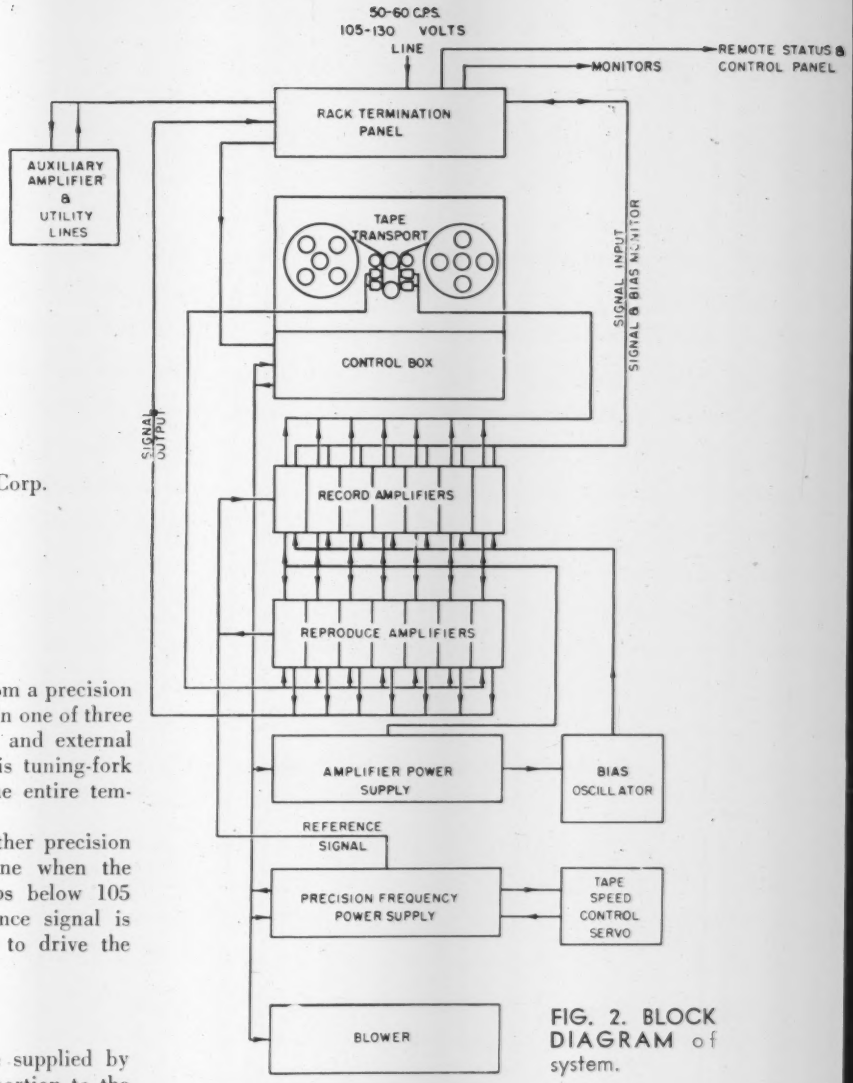


FIG. 2. BLOCK DIAGRAM of system.

Power Supplies

Power for the capstan motor comes from a precision frequency power supply and is available in one of three forms; precision frequency, direct line, and external frequency. Precision frequency supply is tuning-fork controlled at 60 cycles ±.01% over the entire temperature range.

A "fail-safe" circuit switches from either precision frequency or external frequency to line when the voltage from the power amplifier drops below 105 volts. Modulation for the 17-kc reference signal is available from whatever is being used to drive the capstan motor at the time.

Reel Drives

For constant tape tension the torque supplied by the motor should increase in exact proportion to the decrease in its operating speed. The ideal drive for the take-up reel would be a constant-horsepower motor. However, a-c induction motors are constant torque and not constant horsepower. Therefore, each of the two reel drives is supplied with a variable friction brake, the amount of friction being determined by the position of follower arms which make contact with the tape on the reels. The bottom follower on the take-up reel decreases the drag on its variable friction device as the tape builds up on that reel, so that as the moment arm increases and the torque required to maintain constant tension increases, the reduced drag makes this increased torque available.

Precision Plate

The front surface of the plate is flat to within 50 millionths of an inch and is parallel to the mounting surfaces within the same limits. Magnetic head gaps are aligned to ±50 micro-inches, and the line of the gaps in each stack is perpendicular to the base of that stack to within 0.02°. Proper positioning of head stacks on the precision plate is assured by providing a locating hole on the base of the stack which is in line with the gap line to within 0.0005″.

The tape contacts the capstan before it is touched by the pinch rollers, and the tape speed is determined by the steel surface of the capstan itself, rather than the deformable surface of the rubber pinch roller.

Auxiliary Equipment

Auxiliary equipment is available to extend the versatility of the recorder.

Conversion to an accurate continuous-loop recorder/reproducer is quickly and inexpensively accomplished with a Tape Loop Adapter. This attaches to the front plate in place of the standard reels. The upper and lower arms are adjustable to accommodate loop lengths from 2 to 26 feet.

A completely integrated mobile test set is designed to check out the recorder/reproducer quickly and accurately (Fig. 1).

For remote operation from distances up to 500′, a remote control is used. This panel provides a second set of transport operating push buttons, a tape-footage meter, and READY and TRANSFER panel lamps.

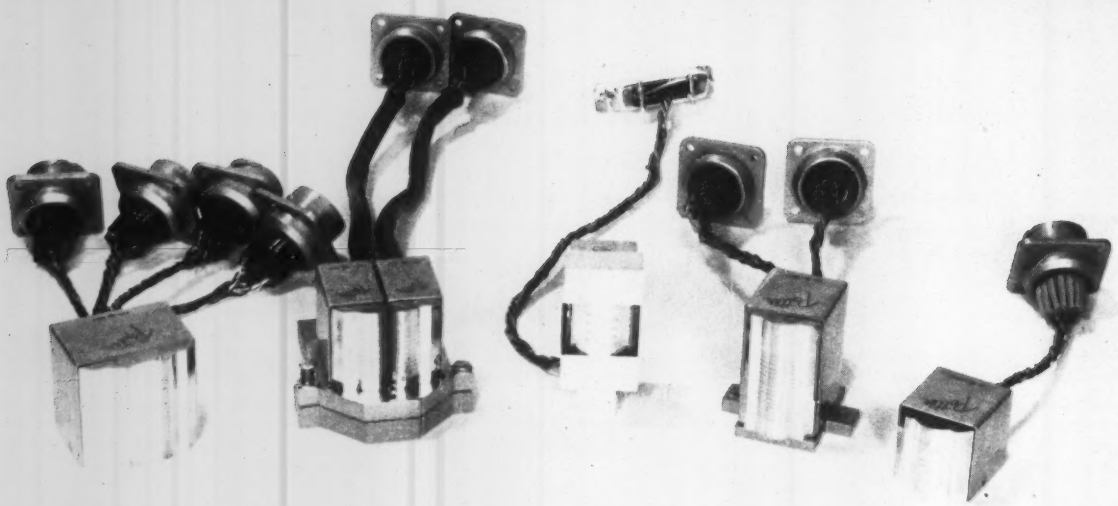


FIG. 1. MAGNETIC HEADS. From left to right: Dual-gap interlaced, up to 49 tracks; dual read-write, up to 25 tracks; RR Univac-compatible; single gap, up to 25 tracks; single gap, up to 12 tracks.

Digital-Recording Magnetic Heads

A survey of the basic features of magnetic heads for digital tape systems.

W. F. HURLEY Potter Instrument Co.

NO MAGNETIC-TAPE RECORDING instrument is better than the magnetic head it employs to record and play back the data. The magnetic head serves three functions: (1) it records electric signals on magnetic tape; (2) it reads information on magnetic tape and converts it into electric signals; and (3) it serves as a magnetic tape eraser, wiping out old information so the tape may be re-recorded.

There are two basic types of recorders—analog and digital. Heads for the latter differ from those for the former in tolerances. Track tolerances for digital record and playback heads must be held to closer tolerances because of the track-to-track inter-relation of the digital code. With analog heads this is not as

TABLE 1—POPULAR HEAD CONFIGURATIONS

Model	Tape Width"	Track Width"	Track Spacing"	T/Chan	Windings L	R	Gap Width"	Characteristics	Read Output at 30"/sec	Write Current
6400-8	5/8	0.025	0.078	400	10 mhy	28 ohms	0.0005	High impedance, tube type.	10 mvp-p	10 ma
6401-7	1/2	0.032	0.070	400	13	28	0.0004	IBM compatible, high impedance.	10	10
6403-8	5/8	0.025	0.078	400* 110	10 1	28 6	0.0005	High-impedance read, low-impedance write.	10	30
6500-25	1-1/4	0.020	0.050	55/55	0.20/55T	6	0.0005	High lateral density; low-impedance, center-tapped windings.	2.2/110T	60 ma/55T
6900-28	1	0.025	0.070	200/200	10	28	0.0005	Interlaced tracks; high impedance center tapped windings.	10/400T	20 ma/200T
7102-16	1-	0.025	0.0625	110 55/55	1	6	0.0005	Dual read-write; low impedance; center-tapped write winding.	2.2/110T	60 ma/55T

significant because each coded signal is on a separate track.

The basic features of a digital head include the following, with values given for one commercial line to show present practice:

Lateral density (medium or high)
Gap (single or dual read-write gap, interlaced or in line)
Track width (from 0.020" to 0.125")
Track spacing (from 0.050" up)
Windings (single, dual and center tapped)
Inductance (from 50 microhenries to 75 millihenries)
Track alignment tolerance (±0.001")
Gap scatter tolerance (±0.00005")
Tape speed (150"/sec maximum)

Typical types in the line mentioned (Fig. 1) include the following:

6400 Single Gap, Medium Lateral Density
6500 Single Gap, High Lateral Density
6600 Dual Gap, In Line, High Lateral Density
6700 Dual Gap, Interlaced, High Lateral Density
6800 Dual Gap, In line, Medium Lateral Density
6900 Dual Gap, Interlaced, Medium Lateral Density
7100 Dual Read-Write, Medium Lateral Density

Classification

A system of classification has been developed whereby the user can specify his requirements, yet stay within the framework of reasonable design and manufacturing practices. Fig. 2 shows one method used in

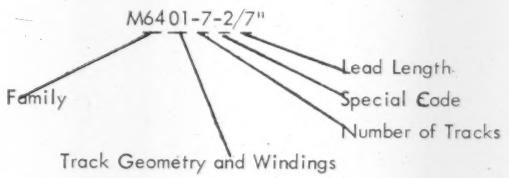


FIG. 2. CODE designation.

classifying various basic designs into a standard series of model designations. Table 1 shows a few of the popular head configurations that are included in one standard series line.

Manufacturing specifications are identified by a combination number consisting of a 4-digit decimal number. The first two digits indicate the family; the second two indicate the track geometry and winding data within the family and are followed by a one- or two-digit number indicating the number of recording tracks on the tape—followed by a special code number (which may or may not be present), to identify minor variations in connectors, wiring, etc., followed by a number indicating lead length from the head to its connector. (Lead length is defined as the distance between the back surface of the head and the connector mounting flange.)

The features of construction covered by the model designations are: lamination shape, thickness, and material; track widths; channel spacing; number of windings; number of gaps; gap width; gap separation; track orientation and type of connectors.

Future design requirements will probably place greater emphasis on system reliability. There will most likely be greater reliance on double-gap write-read heads with more stringent requirements for track alignment, gap scatter, gap width, and track width.

Magnetic Tape Terminology

RDB refers to Joint Army-Navy Research & Development Board recommendations for center frequencies used in FM/FM telemetering sub-carrier oscillators.

PULSE-DURATION MODULATION (PDM), or pulse-width modulation, is a technique in which the analog signal is sampled at intervals. The signal recorded is a pulse whose duration is made proportional to the signal amplitude at instant of sampling (only the beginning and ending of these pulses actually are recorded by spikes).

QUIETING. Refers to noise existing when there is no tape motion, but with the circuitry energized.

DIRECT RECORDING records the amplitude of the signal directly on the tape via remanent magnetization.

DIGITAL RECORDING is recording via binary technique—0 or 1. *Return-to-Zero (RZ)* method saturates the tape in one direction signifying binary digit zero, and saturates the tape in the opposite direction for a binary one; after each frame in which a digit one (1) appears, the tape orientation is returned to that representing zero. *Non-return-to-zero (NRZ)* changes the direction of orientation only when a binary one appears. Otherwise tape is left unchanged at its previous saturation. When orientation is not changed during a frame it signifies binary zero.

CHANNELS. Separate data origination sources. This word is avoided in describing separate tape tracks because many channels sometimes are put on one tape track by multiplexing.

DYNAMIC RANGE (signal-to-noise ratio) is the ratio of the maximum signal which can be recorded (at a given level of distortion) to the minimum signal which can be recognized (determined by the inherent noise level of the system).

BIAS. A high-frequency signal, mixed with the desired signal, used to place the operating point of the recorder on a linear portion of its characteristic. D-c bias is sometimes used.

WOW AND FLUTTER. Originally referred to small deviations in tape speed about the nominal value (flutter—high frequency; wow—low); as modern tape transport performance is so good that other noise errors are of significance, this term now usually includes all sources of noise—tape defects, head-tape contact, etc.

HEADS. The electromagnets which transfer signals to and from the magnetic tape.

RECORD AMPLIFIER. The assembly which prepares the signal for recording. It may include, in addition to amplification, functions such as bias or carrier oscillation and changes in data form necessary for recording on tape.

ELECTRONIC

The circuit is the heart of all electronics. Here are 3 more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

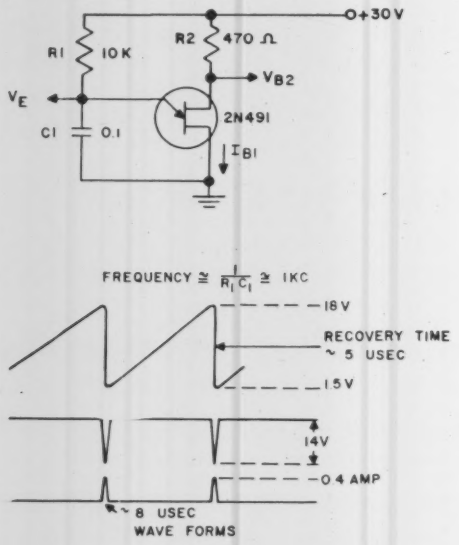
UNIJUNCTION RELAXATION OSCILLATOR CAN OPERATE FROM LESS THAN 1 CPS TO 800 KC

Now available in commercial quantities, the unijunction transistor exhibits stable negative-resistance characteristics. Formerly called the double-base diode, the device was invented by Dr. I. A. Lesk of General Electric. The unijunction transistor corresponds roughly to a thyratron; any of the three terminals, however, can serve as a signal input or load output.

Internally, the transistor consists of a silicon bar with ohmic contacts (base 1 and base 2) at each end, with an aluminum wire (emitter) attached to the bar between them. Supply voltages are polarized to make base 2 positive with respect to base 1. With the emitter at ground potential, only a small leakage emitter current flows, and a small base-to-base current flows. As the emitter voltage is made more positive, an emitter potential is reached at which *holes* are injected into the silicon bar. The increased charge concentration because of these holes decreases the resistance between the emitter and base 1. The emitter current then increases regeneratively until it is limited by the emitter current power supply. Increased interbase current also flows during this time.

A major electrical characteristic of the unijunction transistor is its *intrinsic standoff ratio*. It is approximately equal to the *ratio* of the peak emitter voltage to the interbase voltage. For the type 2N491 in the circuit shown, intrinsic standoff ratio is 0.62. Thus, when the emitter potential is raised to 62% of the base-2 voltage, or about 18 v, the transistor is turned on.

In the circuit shown, a sawtooth waveform of 16.5-v amplitude is generated across the capacitor. Before power



is initially applied, voltage across the capacitor is zero, and the transistor is cut off. When power is applied, the capacitor charges exponentially toward the 30-v supply potential until the emitter reaches 18 v. The emitter then conducts heavily (current flowing to base 1), discharging the capacitor to 1.5 v. Current flow then ceases, the capacitor recharges through the 10K-ohm resistor (R1), and the cycle repeats.

During the capacitor discharge, a 0.4-ampere current pulse flows in the emitter to base-1 circuit; duration of this pulse is about 8 usec. The capacitor discharges in about 5 usec. Increased current flowing in base 2 causes a voltage pulse across the 470-ohm resistor R2; a 14-v 8-usec negative-going pulse is produced at base 2.

Low-voltage output pulses also can be obtained across small resistors connected between the capacitor and ground or between base 1 and ground. If inserted, these resistors will affect the discharge time of the capacitor; 5 ohms is a reasonable value, providing 2-v pulses.

Frequency of oscillation is determined by the intrinsic standoff ratio and the time constant R1-C1. Standoff ratio may vary by ±10% from one transistor to another, producing approximately the same percentage change in frequency. Frequency is nearly equal to 1/(R1) (C1) or about 1-kc for the values shown.

Higher or lower frequencies can be obtained by changing values of R1 and C1. The upper limit of frequency is 0.8 Mc; as this frequency is approached, current and voltage waveforms degenerate into sine waves and their amplitude is markedly decreased. Lower frequency limit is determined by emitter leakage current and by minimum emitter triggering current; oscillation at frequencies well below 1 cps are possible.

If the rms power rating of the unijunction transistor is not exceeded, current pulses of 2 amperes peak from emitter to base 1 are permissable with values of capacitor C1 up to 10 uf. When still larger capacitors are used, emitter current should be limited by inserting series resistance of at least one ohm per microfarad in the emitter or base-1 circuit.

Linearity of the sawtooth waveform across the capacitor is poor because the charging curve is exponential. Linearity can be improved by returning resistor R1 to a voltage higher than 30 v (say 60 v), keeping base 2 on the 30-v supply. This will confine the operation to a more nearly linear portion of the exponential charging curve; value of R1 must be increased to maintain the same oscillation frequency.

Frequency of oscillation is relatively insensitive to power supply voltage because of the intrinsic-standoff-ratio characteristic of the transistor. If the supply voltage were increased to 40 v for example, the capacitor would charge to 24-v in RC seconds; the emitter voltage required to turn the transistor on, however has increased to 0.62 x 40 = 24.8 v. The sawtooth period, therefore, remains practically constant.

Frequency of oscillation: 1 -kc approx. for circuit shown; can be altered (by changing RC value) from 800 kc to less than 1 cps.

Output: Sawtooth waveform at emitter, 16.5-v amplitude; 14-v negative going pulses (at base 2) of 8-usec duration.

Frequency stability: Better than ±1% for supply volt-

CIRCUITRY

CHARLES F. KEZER

and

MILTON H. ARONSON

age between 10 v and 40 v; Stability of ± 0.1% can be obtained for same operating conditions by selection of R2, for temperature range from −50°C to +100°C.

Output impedance: 470 ohms at base 2; external load at emitter should be 100K ohms or higher.

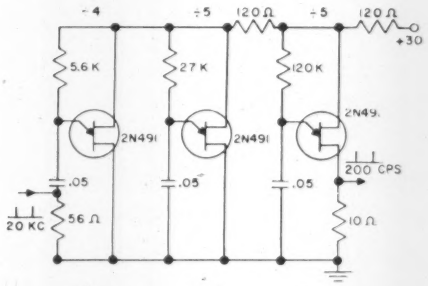
Power supply: 30-v dc at 4 ma.

Source: Bulletin ECG-272, Semiconductor Products Dept., General Electric Co., Syracuse 1, N. Y.

UNIJUNCTION FREQUENCY DIVIDER DIVIDES 20-KC INPUT BY 4, 20, AND 100

Three unijunction relaxation oscillators of the type shown in the previous circuit are cascaded in this circuit to form a 100:1 pulse-frequency-divider.

Time constants of each stage are chosen to produce free-running oscillations at a slightly slower rate than the actual operating period. The first stage, for example, has a time constant of 280 usec, and would thus have a free-running frequency of about 3.5 kc. However, as the input to this stage is a strain of pulses at 20-kc repetition rate,



its output frequency is forced to be 5 kc (the submultiple of the 20-kc input that is nearest to the 3.5-kc natural frequency). Thus the stage divides by four. Every fourth input pulse drives the emitter to the turn-on voltage *before* the emitter voltage would have triggered the transistor in the absence of input pulses. Thus the free-running frequency is chosen to be slightly *less* than the desired operating frequency.

When the first transistor is triggered (every 200 usec), about 30 ma of current flows in its base-2 circuit. This current, passing through the 120-ohm resistor in series with base 2 of both first and second stages, produces a 4-v negative-going pulse. The second stage is triggered by every fifth one of these pulses at its base 2. It cannot trigger at other times because its emitter capacitor has not charged sufficiently and the emitter voltage is too low.

When the second divider stage triggers, a 4-v negative-going pulse is presented at base 2 of the third divider stage (by current flow in the second 120-ohm resistor in the third-stage base-2 circuit). The RC time-constant of the third stage is 6000 usec; thus it can trigger only on every fifth input pulse, corresponding to an output period of 5000 usec. Output pulse-frequency is thus 200 pps.

Output at base 1 of the third stage is a train of positive pulses of 4-v amplitude and 5-usec width. Negative output pulses of the same amplitude and duration can be obtained by shifting the 10-ohm output resistor to place it between the 0.05-uf capacitor and ground.

Input pulses are positive, 1-usec wide, and 4-v amplitude. Input source must be capable of supplying these pulses to the 56-ohm input impedance of the first divider; as the emitter current is high when the transistor turns on, there may be considerable loading on the source.

Circuit can be used at other input and output frequencies provided the time-constants of each stage are changed proportionately. Extremes of frequency are limited as described in the preceding circuit.

Input: 1-usec positive pulses, 4-v amplitude, 20-kc repetition rate.

Output: Positive pulses, 4-v amplitude, 5-usec duration, 200-pps repetition rate.

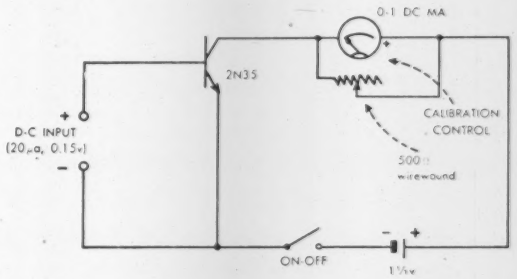
Power supply: 30-v dc at 10.5 ma.

Source: Semiconductor Products Dept., General Electric, Syracuse 1, N. Y.

TRANSISTOR D-C MICROAMMETER USES 1-MA MOVEMENT

A single type 2N35 NPN junction transistor is used in this circuit to deflect a 0-1 ma d-c meter to full-scale on input current of 20 ua. The milliammeter is less expensive and more rugged than a microammeter.

The 1½-v flashlight cell, transistor, and calibration potentiometer can be mounted directly to the rear of



the meter case. Some steady current may flow in the meter with no input current, due to the cutoff current (I_{co}) of the transistor. The meter can be initially set to zero with its mechanical zero-set screw. It is calibrated by applying a known 20-ua current to the input terminals, adjusting the calibration control rheostat for full-scale meter deflection.

Power supply: 1½-v jumbo-size flashlight cell; current depends on input.

Input resistance: At full scale, 7500 ohms.

Source: Booklet, 28 *Uses for Junction Transistors*, Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

A NEW SERIES

Process Control Systems

FRED D. MARTON, Instruments Publishing Company

SINGLE-ELEMENT SELF-OPERATED FEEDWATER REGULATOR USES THERMAL EXPANSION GENERATOR

There are four types of feed-water control systems in common use today:

1. Single-element self-operated.
2. Single-element pilot-operated.
3. Two-element pilot-operated.
4. Three-element pilot-operated.

The single-element self-operated feedwater regulator has been used for many years, and is still in use to some extent on small, low-pressure boilers, having relatively stable flow characteristics. One type of regulator falling in this category is shown.

A generator, consisting of two concentric tubes, is installed at a suitable location on the boiler drum, the inner tube connected at points above and below the drum water level so that the level in the inner tube corresponds with the level in the drum.

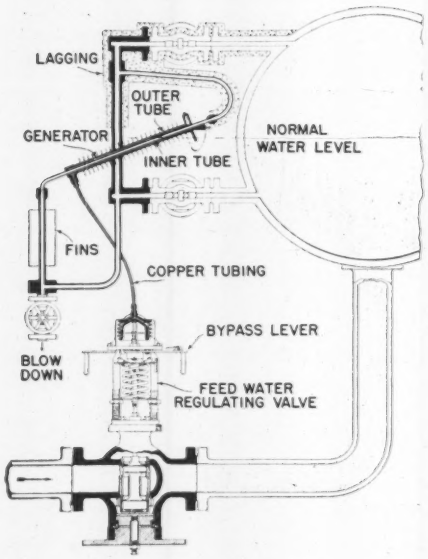
The annular space between tubes of the generator is filled with water when the generator is cold, and is connected by means of tubing to a bellows-operated, spring-closing feedwater valve installed in the feedwater line.

In normal operation, the water level in the inner tube changes with the water in the boiler drum, releasing more or less heat to the outer tube as the water level varies. When the boiler water level drops, more heat is released to the outer tube, creating a pressure, and forcing the valve open.

A regulator of this type has a proportional band of about 6 inches, so that at low ratings the water level is somewhat above normal, and at high ratings, somewhat below normal. This range has been found necessary to insure stable operation.

This type of regulator has the advantages of being extremely simple in operation, low in cost, and requires no external source of power. It does, however, have a number of disadvantages aside from the rather wide proportional band, which restricts its use to small boilers and those having a relatively steady steaming rate.

As is well known today, an increase in steaming rate causes release of steam bubbles below the surface of the water in the boiler, raising the water level in the boiler drum, and tending to close the feed water valve. Obviously, if an increase in steaming rate has taken place, it will be necessary to provide more water, not less, in order to maintain a satisfactory balance. As the valve tends to close on an increase in rating, the relatively cool water entering the boiler drum is decreased, which causes a further increase in steam bubbles below the surface and a corresponding increase in level. However, after a very short period, the water level will tend to drop rapidly and, since steam is being removed from the boiler at a much greater rate than water is being supplied to it, the valve will open, increasing the rate of relatively cool feedwater, which will collapse some of the steam bubbles below the surface, and cause a decrease in water level at an accelerated rate. Consequently, on any change in steaming rate, a severe cycling is encountered in feedwater flow to the boiler, upsetting the heat balance of the entire boiler. This action is characteristic of single-element self-operated regulators of all types.



Source: Bailey Meter Co., Cleveland, Ohio; also Product Specification M 85-1.

PURGE INTERLOCK SYSTEM MONITORS FUEL SUPPLY TO BOILER IN STEAM GENERATING PLANT

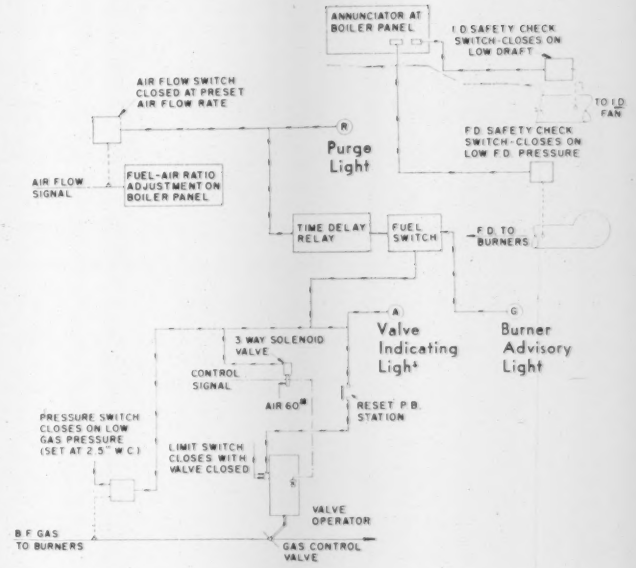
When a boiler has to be shut down for repairs or for other reasons, the purge-interlock system prevents the possibility of introducing fuel when the forced-draft fan is not delivering at the required rate.

An air-flow switch closes at a pre-set air flow-rate taken from the air-flow signal going to the fuel/air ratio adjustment on the boiler panel. When the switch closes, a red purge light comes on, indicating that the time-delay relay is energized. The fuel switch is then turned to "fuel-on" position and, when the preset time has elapsed, a green *burner advisory light* comes on at the same time a 3-way solenoid valve is energized. The solenoid valve allows the control air signal to reach the valve operator (bottom). However, the valve operator does not start functioning before the reset pushbutton is pressed, which opens the limit switch on the operator. An amber light indicates that this operation has been performed.

A pressure switch in the gas line, set at 2.5″ WC, closes and shuts off the gas supply via the valve operator and gas control valve when the pressure in the line reaches a low limit.

Low induced draft or low forced draft is monitored by lights on annunciator of boiler panel. These are controlled by safety check switches.

Source: Hagan Chemicals & Controls, Inc.; also J. P. Katzenmeyer, "Instrumentation of a Modern Steam-Generating Facility," *Instruments and Automation*, June, 1955.



WASTE CONTROL VIA CONDUCTIVITY AND pH

In many soldering operations the parts are dipped in a 50%-nitric 50%-sulfuric acid bath (bright dip) to remove dirt and prepare the surface. The parts are then rinsed in a water bath, which becomes progressively more acid.

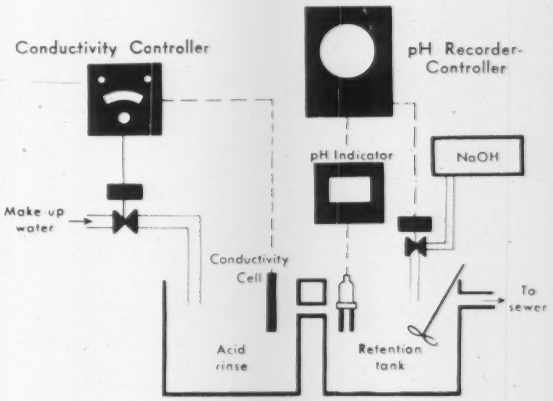
Make-up water is added to the rinse to keep it from becoming too acid, and the overflow is discharged to a sewer. The discharge must be neutralized by NaOH (caustic soda) to prevent contamination of the water to the municipal sewage-treatment plant.

The problem is to minimize the amount of make-up water and the amount of neutralizing NaOH.

Addition of the make-up water in the rinse bath is controlled by the measurement of conductivity, which is a measurement of *all ions* in the bath. In this step of the process, conductivity measurement instead of pH is more economical to use because the effluent is neutralized before discharge. An accurate measure of pH is not needed.

The conductivity cell keeps the rinse acidity within reasonable limits by a nonrecording on-off Electromax Conductivity Controller with an electrical output fed to a solenoid valve controlling water addition.

The overflow from the rinse is retained in a retention tank for neutralization by NaOH. Here a pH electrode is connected to a pH indicator, whose electrical output is fed to a potentiometer (Speedomax position-adjusting H) recorder-controller. The electric output of this controller is fed to a position-adjusting Series 10260 electric-control drive unit which controls the addition of the caustic soda reagent. At the legal concentration of 7.5 pH, the effluent is dumped.



Source: Leeds & Northrup Co., Philadelphia, Pa., also *Modern Precision*, Vol. 17, No. 1.

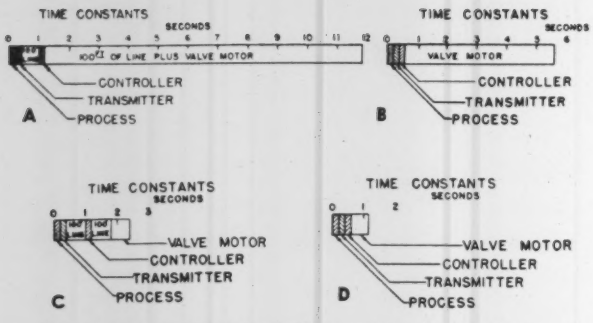


FIG. 1. TIME CONSTANTS (seconds) of 150-cubic-inch valve actuator to step load change for (A) 100' line, no booster, (B) no line, no booster, (C) 100' line with booster, (D) no line, with booster. (Courtesy The Foxboro Co.)

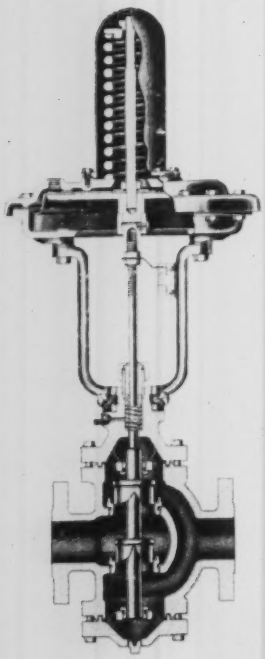


FIG. 2. TYPICAL STABILFLO actuator. (Courtesy The Foxboro Co.)

TABLE 1—ACTUATOR CHARACTERISTICS

NOMINAL SIZE	SMALL	MEDIUM	LARGE	VERY LARGE
Stroke - Inches	¾	1-⅛	1-¾	3
Motor Diameter Inches	10	15	19	21
Average effective area Square Inches	38	72	120	230
Zero Stroke Volume Cubic Inches	22	105	135	....
Full Stroke Volume Cubic Inches	57	200	387	1296
Conventional Full Stroke Time-Seconds	4	10	23	50
Full Stroke Time With Booster-Seconds	0.3	0.8	2.3	4.5
Foxboro Valve Motor Number	6	8	10	....

Response of

FRED D. MARTON

Instruments Publishing Company

DYNAMICS of pneumatic valve actuators have been reported in a paper by Catheron and Hainsworth**, from which the following data are abstracted.

Measurements were made of the dynamics of control valve operators with various lengths of pneumatic transmission lines. The figures show the relative effect of each of the system components, based on the recovery from a 10% load upset, and a bar chart of the summation of the time constants of each of the system components.

The first test (Fig. 1A) was made with 100 feet of 0.188"-i.d. metal transmission line from the differential-pressure transmitter to the controller, and 100' of transmission line from the controller directly to the 150-cubic-inch valve actuator. Fig. 1B shows the improvement of control and the increase in speed of response afforded by eliminating the transmission line. Note that the dominant response lag is in the valve actuator.

The next step was to mount a volume booster, essentially a volume relay, on the valve actuator. The output signal of the controller (3 to 15 psig) is transmitted to the small volume (1.6 cubic inches) of the booster; the booster, with an air-handling capacity of about 14 cubic feet/minute, supplies the valve actuator with power.

Fig. 1C and 1D shows the response of the systems of Figs. 1A and 1B when the volume booster is installed at the valve. The same 10% load upset is used. There is a marked improvement in control performance and a marked decrease in the lag attributable to the valve actuator (and its transmission line).

Comparison of the Figs. 1B and 1C shows that the system with the volume booster and 100 feet of transmission line gives nearly the same performance as the conventional controller mounted directly at the valve.

**Allen R. Catheron, Bruce D. Hainsworth, The Foxboro Co., "Dynamics of Liquid Flow Control," *Instruments & Automation*, Aug. 1956.

Pneumatic Valve Actuators

The response of combination (electropneumatic and electrohydraulic) and electric valve actuators was discussed in previous issues. Here are some response data for conventional pneumatic actuators, including diaphragm and piston.

This again bears out the fact that it is the large volume of the end of the transmission line that is most harmful—not the line itself.

Fig. 1C shows that the response of the transmission system now has a relatively greater effect (although not great in terms of time) on the dynamic response of the system.

Foxboro Stabilflo Valve Actuators

Table 1 shows the response (conventional full-stroke time, seconds) for the Foxboro 6, 8, and 10 actuators (Fig. 2) as reported in a paper by Allan R. Catheron.*

Fisher Governor Type 470 Piston Actuator

Frequency response of this actuator (Fig. 3) with an i.d. of $8\frac{1}{2}$" is 1.4 cps. (For the $4\frac{3}{4}$" cylinder it is 4-cps.) The transfer function for the $8\frac{1}{2}$" size is

$$T_a = \frac{77.2}{S^2 + 17.5S + 77.2}$$

based on a 2" travel with a 3-15-psi instrument signal. If it is desired to convert this dimensionless function to units of inches/psi, a factor of 1/6 must be used.

Fig. 4 shows *magnitude ratio* and *phase shift* versus *frequency* curves for the Type 470 (size 60) having 2" travel, for 3-to-15 psig control pressure and 5% input at 9 psig mean level.

Fisher Type 657 Diaphragm Valve with Positioner

The response curves for the Type 657 diaphragm control valves, equipped with a Positrol pneumatic

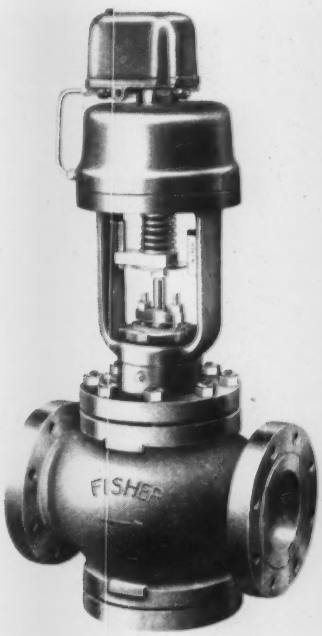


FIG. 3. TYPE 470 piston actuator (Courtesy Fisher Governor Co.)

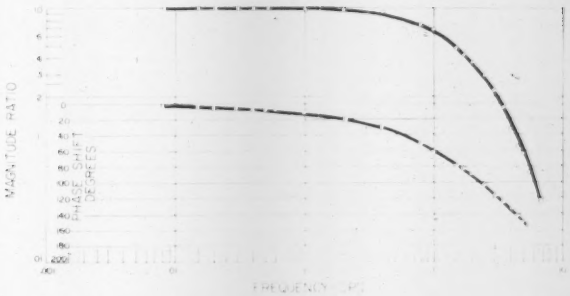


FIG. 4. RESPONSE of 470 actuator, 2" travel, 5% input amplitude at 9 psig mean level. (Courtesy Fisher Governor Co.)

*Factors in Precise Control of Liquid Flow, ISA Paper 50-80-2, Allan R. Catheron, The Foxboro Co.

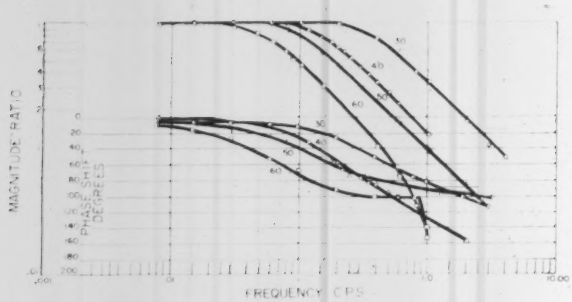


FIG. 5. RESPONSE of Type 657 with Positrol positioner. Courtesy Fisher Governor Co.)

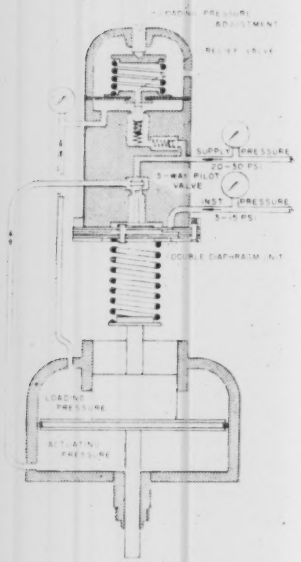


FIG. 6. DOMOTOR actuator. (Courtesy Annin Co.)

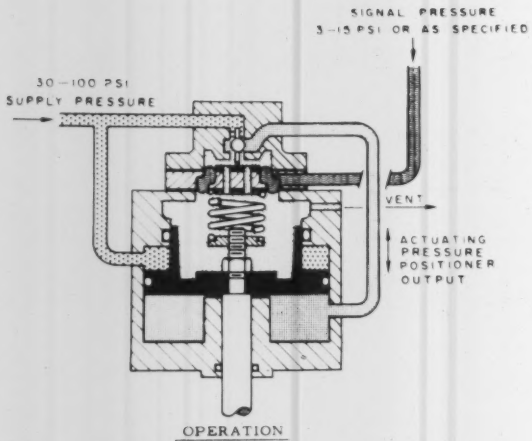


FIG. 7. SERIES 600 actuators.

valve positioner (Type 3500) are shown in Fig. 5. The curves represent response of four sizes of actuators as follows:

Size 30 with $\frac{3}{4}$" travel
Size 40 with $1\frac{1}{2}$" travel
Size 50 with $1\frac{1}{2}$" travel
Size 60 with 2" travel

Annin

The Annin Company offers a line of on-off pneumatic actuators. Domotor positioning actuators (Fig. 6) and Series 600 positioning actuators (Fig. 7).

The response times of these actuators are given in Tables 1 and 2, and in Fig. 8.

TABLE 1—RESPONSE OF ON-OFF TYPES

Type	Actuator Area (sq in)	Stroke (inches)	Force (lbs)	Response* (seconds full-stroke)
Series A	12.6	0.50	1890	0.06
Series B	28.3	0.75	4250	0.17
Series C	50.3	1.50	7540	0.35
Series D	103.9	2.50	15,590	0.86
Series E	201.1	6.00	20,110	6.00

TABLE 2—RESPONSE OF POSITIONING TYPES

				Response**
A Domotor	35.8	0.75	3580	0.99 cps
B Domotor	56.8	1.5	5680	0.875
C Domotor	103.9	2.5	10,390	0.397
D Domotor	201.1	6.0	20,110	0.596
E Domotor	415.5	6.0	41,550	0.162
643	12.6	3.0	640	0.94
644	28.6	4.0	1440	0.785

*Cylinders with $\frac{3}{8}$" NPT 3-way and 4-way solenoid valves. Faster operation in either direction is possible by sacrificing speed in other direction.

**Break-point frequency (cps) to 0.707 amplitude ratio with 10% of full-stroke signal.

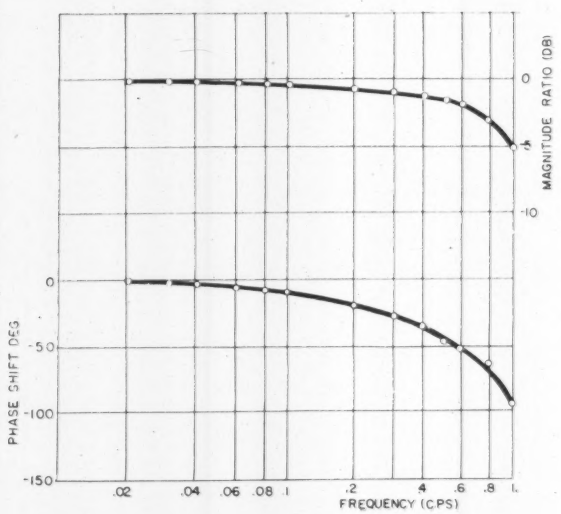


FIG. 8. SERIES 600 response. ►

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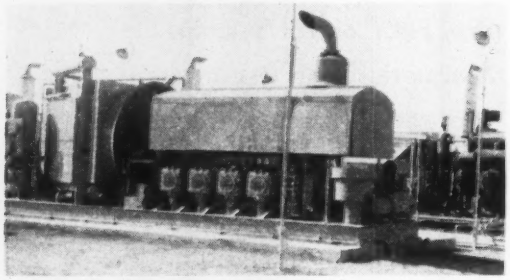


FIG. 1. UNATTENDED gas engines on compressors at Saticoy.

Telemetering for an Unattended Compressor Station

Entire plants now can run untouched by human hands. Automatic shutdown equipment usually is provided to protect against damage in case of failure of automatic machinery operating unattended. Such a shutdown can represent a considerable loss unless some method of calling help is provided. The alarm system also must determine the degree of emergency.

GEORGE A. RUTLEDGE
The Bristol Company

TELEMETERING can be done in several ways. The type chosen by Shell Oil for the Saticoy compressor station is a *time-sharing multiplex* system.

Saticoy compressor station gathers gas from a number of wells nearby and delivers it to a Pacific Lighting Gas plant near Ventura, California, through a pipe line. The Saticoy station operates unattended. Its compressors are powered with gas engines which have automatically operated shutdown safeties. Unfortunately the gasoline plant superintendent at Venturi had no way of knowing when a shutdown had occurred and losses of gas delivery would continue for hours before discovery.

It was felt that a telemetering system that would signal a shutdown to Ventura would pay for itself quickly. At first a simple device that merely registered shutdown was discussed, but it was felt that a more elaborate system that indicated the number of compressors down would be necessary in order to determine the degree of emergency. The limiting factor was the communication channels available. Shell Oil Co. had a telephone line to which four tone channels could be added. However, as great speed of sending was not of extreme importance, a time-sharing multiplex system was chosen.

April Meeting: Thursday, the 16th, Rio Hondo Country Club, Downey, Calif.

Feature: to be announced

Operation

In this system, each compressor condition (or any other variable) is interrogated in turn. Up to fifteen variables can be transmitted.

The time-sharing multiplex consists of two commutating switches, one at each end of a communication channel. Fifteen separate circuits are placed on the channel for fifteen seconds each. Three of these 15-second periods are used to send two pressure readings and one flow reading with a time-pulse transmitter. At the receiver end, the signals are connected

Presented at SCMA meeting, Jan. 15, 1959, Rio Hondo Country Club, Downey, Calif.

to an impulse-duration recorder. Power is applied to the receiver only when a signal is being received. Thus the pointer or pen is stationary between signals. The impulse used has a 5-second cycle, with 1 second corresponding to zero and 4 seconds to full scale. Since the multiplex keeps each transmitter on the line for fifteen seconds, three complete signals are transmitted in each 15-second interval.

In compressor *operation*, the intelligence is a little harder to telemeter. A pressure-operated switch in the lube oil line closes when the compressor is running and opens when it shuts down. All the compressor circuits are connected in series with one of the impulse transmitters which are used for pressure or flow. When a compressor is operating, the signal varies between 1 and 4 seconds, depending on the position of the impulse transmitter used. However, when the switch is open, indicating that a particular compressor is not operating, no signal is transmitted for the duration of time the multiplex is interrogating—15 seconds.

At the receiver panel a timer for each compressor is powered only during its turn to interrogate. If a signal impulse between 1 and 4 seconds is received, a relay is locked in electrically, which lights a green light on the panel. If no signal is received (indicating the compressor is down) the timer closes a switch which shorts the holding coil of the relay, dropping it out and lighting a red light. There are a pair of operating lights for each compressor, a pair for a glycol pump and a pair for a high-temperature alarm. The lock-in relay operates a pair of contacts for an external horn or bell; a manual switch is provided to silence the bell for each alarm signal.

After the fifteen variables have been interrogated, the multiplex transmitter itself puts a signal of 7 or 8 seconds on the line. This is the synchronizing signal: the multiplex receiver stops and waits for it. At the end of this signal, both transmitter and receiver start together. Thus any slight timing error is corrected each scanning period. Should power be off one end of the circuit for any length of time, however, the multiplex would become badly out of time and one complete scanning period might be required for the synchronizing signal to bring the system back into time again.

When an alarm indicates that a running compressor has gone down the gasoline plant superintendent at Ventura silences the bell and checks suction and discharge pressure. If suction pressure is low, indicating there still is excess pumping capacity, he will let the shutdown go until the next routine check at Saticoy. If the suction pressure is up, indicating a need for pumps, a man is dispatched at once to get the compressor back on the line.

The time-sharing multiplex puts a lot of information over a single channel, but at a sacrifice of speed. In the system described, fifteen pieces of information can be transmitted , but each item comes in approximately every four minutes. Therefore, the information may be up to four minutes late. However, if there are fewer than fifteen variables, an important one can be put on the line twice or three times, at pre-selected intervals, during the four-minute period.

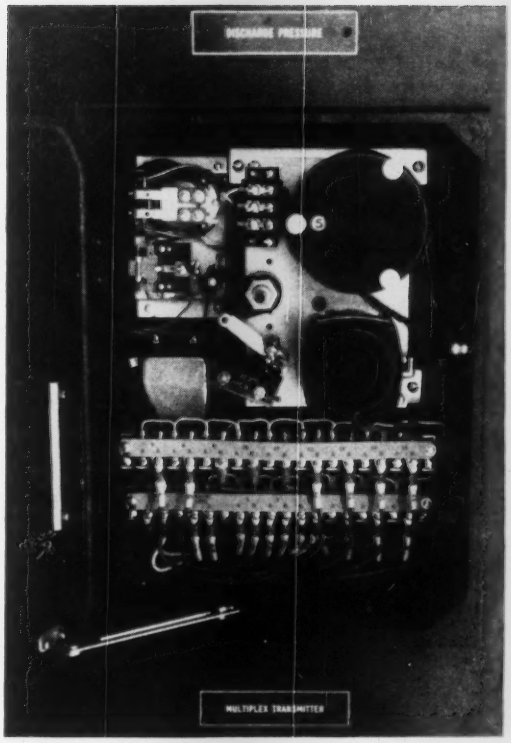


FIG. 2. MULTIPLEX located at Saticoy sends signals to Ventura.

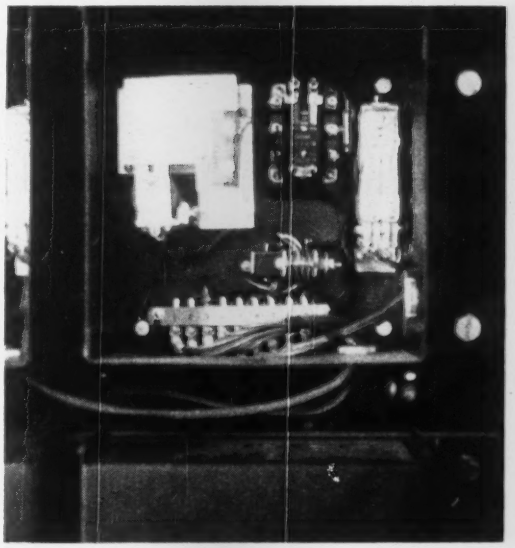
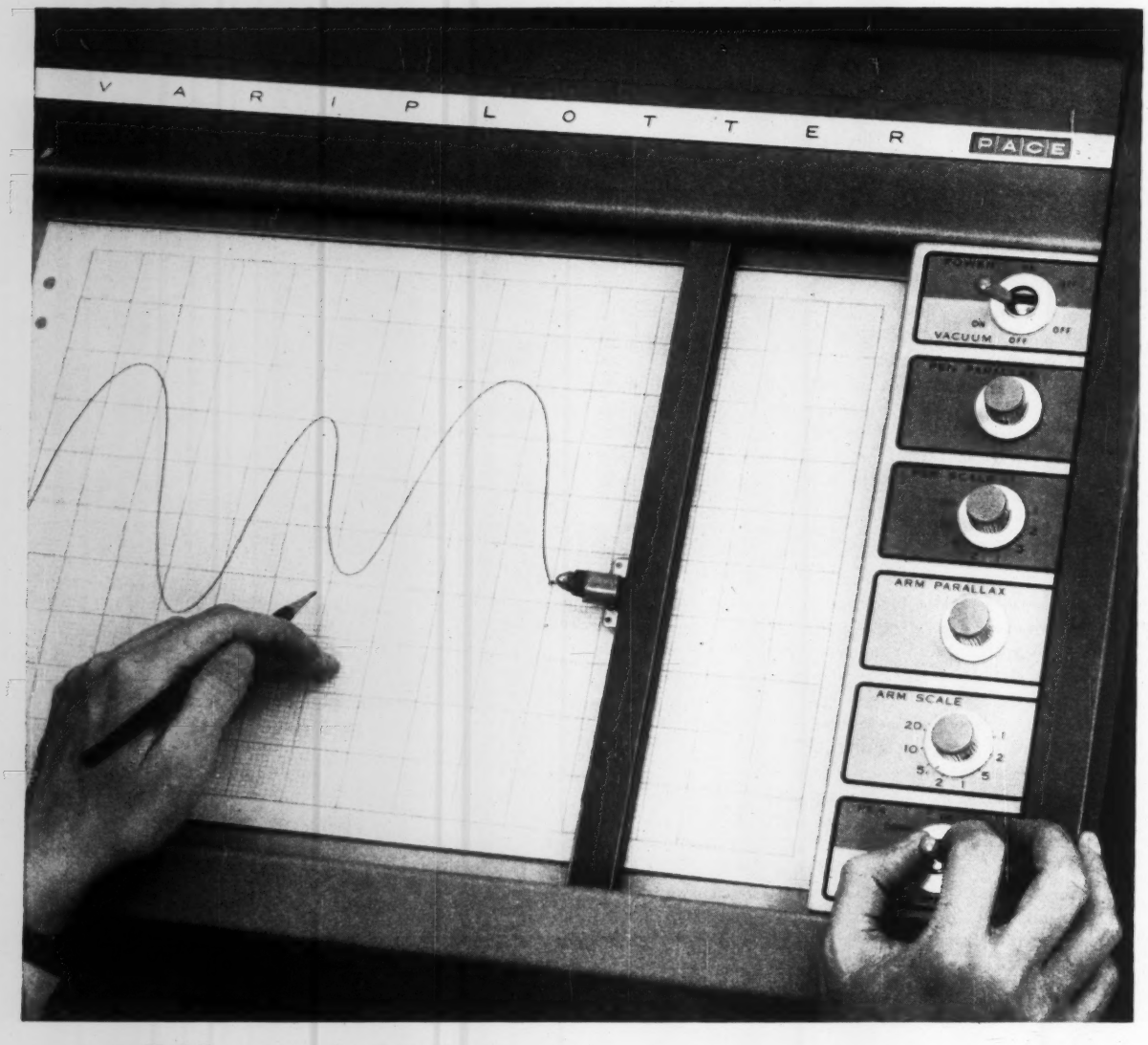


FIG. 3. TIMING SWITCH at Ventura. Telephone-type switch is at right and lock-in relay is in center. When compressor is running the arm on the timer never reaches the contact (due to the continually interrupted signal) and the relay is locked in, lighting the "running" light. If incoming signal is not interrupted while the timer is energized, the timer contact shorts the holding coil and lights the "stopped" light.



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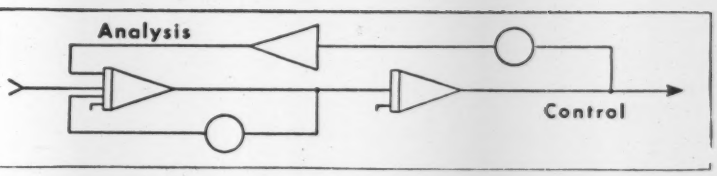

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Bits

This month we finish up the story of our three Innocents (?) Abroad (Gene Grabbe, Max Palevsky, and Ed DeLand) as told to the January 8th meeting of the Western Simulation Council, and then present notes on the activities of the study groups of the WSC which met that same day. And as if this were not enough, we have Charles Halijak's story of the Central Simulation Council's meeting on February 2nd. Plus an Info and a Thataway.

Pieces

WESTERN S/C MEETING OF 8 JAN

We checked the tape recording of *Eugene Grabbe's* (Ramo-Wooldridge Corp., Los Angeles) story of his trip to Russia as told to the January 8th meeting of the Western Simulation Council and reported in last month's *Newsletter*, and noted a few comments which might be of interest and which were not in the writeup of his more formal Association for Computing Machinery presentation, on which last month's report was based.

Examples: There are probably four or five thousand Russian analog installations as compared with three or four hundred digitals, possibly because the Russians say the Germans advised analogs for industrial control. (We have about five thousand digital computers.)

They use thyrite multipliers. Instead of designing equipment for a particular job they will, when possible, use existing components: e.g., they have 35-mm film transports so they use punched film computer inputs.

Instead of quality checking their magnetic cores they simply put extra rows and trays in their magnetic memories and don't use the bad ones.

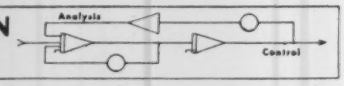
All machine-tool computers are transistorized, some with telephone dial inputs.

They use soldered wire rather than printed circuits.

They do a great deal of copying, particularly in consumer goods, in an effort to catch up by skipping the R&D phase. This, however, means they are about five years behind in these areas.

They also copy U. S. publications (photo offset?) to the extent that many are said to have a greater circulation in Russia than in this country. Gene showed a photograph of a newsstand on which there were several recognizable copies of U. S. publications, including *Instruments & Automation!*

One Russian article on differential analyzers listed 22 references, 21 of them U. S.



Paperbound books selling for as little as 17c and dealing with math problems, Sputniks, space travel, and satellites are popular reading.

Bill Kindle (EAI Computation Center, El Segundo, Calif.) asked about the economics of computing equipment.

Gene replied that it is complicated. A typical plant has a quota and a cost to meet. A markup of 40% seems to be standard in industry, though this doesn't necessarily follow for consumer goods. They make good wristwatches for 27 rubles (approximately $2.70) and sell them for 400 rubles— a markup of nearly 1500%. This is one way of milking money back into the economy.

For an organization to get a computer they must put it in their budget and buy it at the 40% markup.

Asked whether there are restrictions on selling U. S. computers to Russia and the satellite countries, Gene said "Yes, I'm sure there are. In fact, the Russians were quite amused by this. 'Why do you hand us this big market—China and all the satellite countries?' they asked. 'Why don't you sell us things directly? If we really want to get them we can'."

Palevsky on Strasbourg Journées

The next speaker was *Max Palevsky* (Parkard-Bell Computer Corp., Los Angeles, Calif.), who attended the Secondes Journées Internationales de Calcul Analogique in Strasbourg, France, and then toured around Europe a bit.

People from all over the world participated in the Journées, Max said, including the Iron Curtain countries (except China). *Ed DeLand* (Rand Corp., Santa Monica, Calif.), *G. D. McCann* (Calif. Inst. of Tech., Pasadena, Calif.), and *Ro Favreau* (Electronic Associates, Inc., Long Branch, N. J.) were the only Americans Palevsky remembered seeing. Yet all talks referred to American developments, talks, articles, papers, etc.

Max referred to the program, saying there were papers of two kinds, one by groups just starting on analog computers, and others who are further along and interested more in applications. The Japanese are interested in analytical work: determining the *exact* characteristics of components, etc.

There were a number of papers on analog work at the nuclear institute in Yugoslavia, despite the fact that the Russians are not attempting to keep techniques in satellite countries equal with their own.

In general, the lack of money in Europe leads to a great deal of very ingenious work which is not necessary here because of our more powerful computers. Europeans tend to be better grounded in mathematics than we, and blackboards are cheap! This leads to abstract and formalized discussions.

Papers on Digital Differential Analyzers were given by people from Italy and England, and by Max, at sessions which were well attended. Max knows of no continental development of DDA's, but the British are working on them, even more than we in some respects!

Two in particular are interesting. One, at the Royal Aircraft Establishment at Farnborough, has a 10-megacycle clock rate. It is a "next generation" TRIDAC simulator.

A group somewhat further along is that at AVRO. They have a prototype parallel DDA running on missile studies. They also have a pencil and paper design of the final one, which they are starting to build. They need it primarily for trajectory problems because of difficulties with the TRIDAC. There will be a number of digital components—input, output, function generators, etc. Both groups are building transistorized equipment, but a problem is getting hold of high-speed transistors.

Also present at the meeting were a number of Germans, mostly from Darmstadt, a center for computing techniques. They were out of business during the rapid buildup of analog techniques, many of which had originated in their own laboratory.

There was a delegation of Russians from two different groups, an operating one that builds computers and a second group from one of the institutes, probably controls. They wouldn't answer any question that was even vaguely military. Max wanted to know how they guide those gadgets they're putting up. He asked about the relative importance of analog and digital techniques in accomplishing the guidance. The guy looked blank and said, "That is a very practical problem. We at the Institute only deal with theoretical problems!"

The Russians have several special-purpose analogs built for oil-field simulation.* They are very big, each one like a building, Max was told, each simulating a total field, an area 150 miles in diameter, and all of the wells, both extraction and injection. The Russians felt such a simulation would be impractical on digital computers; there is an extremely large set of partial differential equations with hundreds of boundary conditions which, they believe, would take weeks and weeks on a digital computer. One of these machines simulates as many as 750 wells, and 30,000 parameters can be set in. It is estimated that a gain of as much as 10% in total yield can be realized over a number of years.

The Russians also have a tremendous number of passive network analogs for machine-tool control** which are operated by the machine tool operator. They constitute an important project.

Russia suffers from a shortage of railroad equipment, so improving efficiency is of paramount importance. For a couple of years they have been developing a computer to control trains. Into it they feed wind resistance, track conditions, and other factors which must be considered to optimize the operation. The parameter of greatest interest is time; Russian trains run on time! To accomplish this they successively approximate optimum solutions to optimize time (and fuel consumption) within boundary conditions such as speed limits on curves, etc. With this computer they expect to save something like 5 to 10% on fuel while carrying more payload. The computer is an almost completely ferrite digital device operating in parallel. This sounds like a parallel DDA, but it isn't. Max was told that it is an arithmetic computer which is not serial—he could get no further information.***

Irwin Pfeffer was interested to note that Max said the Germans had passed up analogs to work with digital computers while advising the Russians to use analogs. Max explained that this seems to be a matter of East or West Germans, and of process or machine-tool control—i.e., whom do you ask and what do you wish to accomplish?

Gene volunteered that the machine-tool computer mentioned is very similar to the General Electric computer

*See *I&A*, Nov., 1958, pages 1810-1813.

**I&A*, December, 1958, pages 1960-1961.

***See *I&A*, January, 1959, pages 102-105, for more information.

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Diode Function Generators: A Comparison of Types

As we attempt to simulate physical phenomena with greater detail and precision, we find that nature is far less regular than the inquiring mind desires. Our integrators, summers and multipliers fail to create analogs of many unruly variables, and we must turn to the diode function generator for a close approximation of empirical fact. Of the many types of DFG's available none is optimally designed for all purposes. The prospective user must decide which characteristics are most important to him and be content with necessary limitations in other respects. Foremost considerations are faithful simulation, ease and speed of set-up and cost. Let's see how available DFG's compare.

Differences in Curve-Fitting Ability

The precision with which a DFG can approximate a function depends primarily on the number of diode breakpoints and on the ability to position breakpoints where most needed, that is, at X values where the change of slope is greatest. DFG's can be ranked from best (most breakpoints, freely movable on X axis) to worst (fewest breakpoints, at fixed intervals on the X axis). One should exercise caution in applying this rule however, because a large number of diode breakpoints may give rise to other sources of error. This happens because the more diodes conducting simultaneously, the greater phase shift, drift and noise. In newer models this difficulty is overcome by designing circuits so that only those diodes in one quadrant conduct at any given time.

Differences in Set-Up Time

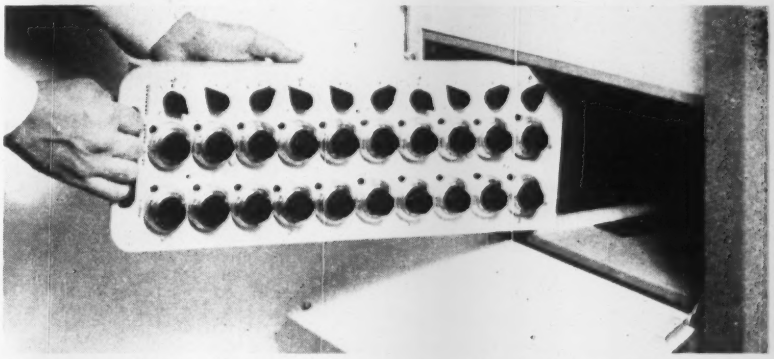
The card-set DFG offers instantaneous set-up once the function has been coded. Holes punched in the card actuate relays which connect resistances into the diode circuit to create desired slopes. Disadvantages are fairly high cost, difficulty in fitting many curves because breakpoints are located at fixed intervals along the X axis, and a possibility of uncorrected errors because the operator cannot easily detect an error in coding. Nevertheless, the rapid switching of functions can be very useful.

The automatic tape-set DFG provides rapid set-up along with greater accuracy and flexibility. One fully automatic model can be set-up from a typewriter or even a digital computer. Drawbacks lie in the great expense of tape logic equipment plus the fact that the initial set-up is difficult to check and requires careful programming.

Semi-automatic DFG's have all the advantages of fully automatic except that initial set-up, being manual, is more time-consuming. An advantage of manual set-up – not to be underrated – is that the operator can easily check the function for errors. Necessary tape logic equipment is much less expensive, though the installation still requires a digital entry system such as the DO/IT.

Pushbutton-set DFG's offer the same accuracy and curve-fitting abilities as semi-automatic models at far lower cost. Functions can be set-up fairly quickly (each breakpoint can be set with pushbuttons in a few seconds); but re-entering a function requires the same labor as an initial entry.

The DFG with manually set potentiometers is still a standby in analog computation. Its high accuracy, low cost and ability to generate varied functions have made it a favorite where lengthy set-up procedures can be tolerated. The slow set-up, its principal disadvantage, has been overcome in the recent EASE model pictured below by mounting potentiometers separately on plug-in modules which permit function change with the speed of card-set models. Costs rise with the number of spare potentiometer modules desired, but expense remains far less than the cost of automatic or semi-automatic DFG's.



The new EASE Model 1177 diode function generator and its mounting unit. Four plug-in function generators are contained in 8¾ inches of rack space. For flexibility, each DFG channel contains ten breakpoints and uses standard inverting amplifiers from the computer. Breakpoints can be located in any quadrant, and high input impedance allows paralleling of several channels. Write for specifications.

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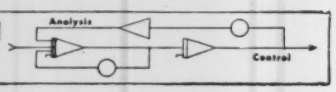

or vice versa. The Russians are also working on hydraulic logical elements and mechano-pneumatic devices like sine-wave generators. IBM has set up a laboratory in Zurich for digital research with European personnel. One project is to build a set of hydraulic digital components—hydraulic flipflops, etc.

DeLand on the Strasbourg Conference

Ed DeLand was next introduced and said he would give a short speech, then scared us by holding up reams of paper. However, it turned out to be a collection of literature picked up at the Strasbourg meeting. "Going to the conference was like a breath of fresh air for analog people," he said. "I stepped back five years into an analog world!"

Ed said that the machines exhibited, except for one Japanese one, did not have replaceable patch panels. However, the components were well engineered, to as high specifications as ours. Some of the machines shown can be patched from front or behind; semi-permanent hookups can be made behind; changeable parameters can be connected in front. Printed circuit amplifiers are used in England. Ed agreed with Max that computer development in Europe is a distributed thing, as is was in this country some years ago, with many individual groups independently building their own. There seems no way to bring all the effort together.

A very important machine in Europe now is the network analyzer with which they hope to simulate the tie-in of all electrical networks of the Central European economic bloc.

The PACE computer was displayed, and was an outstanding center of interest because it had features unlike those of any other computer shown.

And a Dutch Company showed black boxes which take logarithms or, plugged in backwards, antilogarithms—handy little gadgets to have around the house!*

Mr. Helbig (EAI European Computation Center) invited DeLand to be his guest for three days in Brussels. Ed considered the many admonitions about accepting gratuities, considered the price of rooms in Brussels, and accepted! He spent some time at the Fair, but was also interested in the 120-amplifier PACE installation at the EAI Computation Center. All of the equipment is replaced with the latest as it becomes available. They get problems from all over Europe, even though their prices for equipment rental and engineering services are comparable to those in the U. S.

Irwin Pfeffer thanked *Lee Ohlinger* (Northrop Aircraft, Hawthorne, Calif.) for the parking arrangements and luxurious meeting accommodations. Lee explained that he had tried to talk Northrop into treating the crowd to lunch, but was told they couldn't afford to set such a precedent!*

Study Groups

Your Ed. was not able to attend the exploratory afternoon discussion group session because Suzy and I had to drive back to San Diego to speak to the local section of the Instrument Society of America on "Instruments for Simulation".** This was an unfortunate conflict of interests, because Irwin Pfeffer tells us the experiment was quite successful, and we certainly would have liked to be there.

As it is, I cannot report you in any detail because the notes which Irwin was good enough to collect from the discussion leaders are somewhat cryptic.

Analog Simulation Techniques

We gather that George Bekey's group on "Analog Simulation Techniques" talked about the simulation of delays in relays with RC circuits; of hard limits and ideal diodes a la Johnson*; onesided limiters; rate and position-limiting circuits; the generation of functions of large angles a la Howe**; the Reeves rate resolver, servos with stops removed, and multi-turn feedback pots.

They also talked about variable-frequency oscillators, feedback diodes, tangent circuits using one sine-cosine pot, derivative circuits, and function generation of both one and two independent variables.

Some coverage! What was decided? Address George Bekey at the Space Technology Laboratories, P.O. Box 45564 Airport Station, Los Angeles 45, Calif.

Multiplier Committee Reports

Duane Beecher (Hughes Aircraft Co., Culver City, Calif.) led the discussion of the Multiplier Committee of the Analog Computing Equipment Group (seven participants). This group first reiterated their purpose (to establish performance standards) and then considered the difficulties attendant on the measurement of multiplier accuracy. In general the accuracy of the measuring equipment should be at least ten times that of the multiplier. In addition there is a great need for better understanding on the part of the user as to what a multiplier will and will not do. Three-D error plots, as furnished by at least one manufacturer, are very useful in this respect. Multiplier specifications must be complete, otherwise a manufacturer can optimize the stated specs at the expense of unstated ones.

In conclusion, the group seemed to agree with *Joe Hussey* (Berkeley Division, Beckman Instruments, Richmond, Calif.) that the Multiplier Committee should issue a report presenting the findings to date and paving the way for the presentation of improved techniques as they become available.

Maintenance Techniques

Pete Sykes' (Space Technology Labs) group on "Maintenance Techniques" included *Warren Howard* (North American Aviation), *Ralph Wheeler* (Lockheed Missile Systems Division Palo Alto, Calif.), *H. T. Bigelow* (Nortronics, Hawthorne, Calif.), *Bud Hale* (Convair-San Diego).

*For more information write J. E. W. Beneken at the Medisch Fysisch Instituut, The Hague.

*Lee did, however, make arrangements which were probably better than a "free lunch"; by entering designated lines in the cafeteria and identifying ourselves as Simulation Council members we were able to get delicious (really!) steak plates for 65c. In other ways too, the host's management of this meeting was the best we have seen. There were signs at all major intersections within miles of the plant directing us to the Western Simulation Council, and there were Northrop employees at the plant entrance who directed us to reserved parking and to the registration desk, where there were others assigned to help us register, tag us, and escort us to the conference room.

**A plot to set up a demonstration of our heart and lung simulator. See *I&A* for January '59, p. 18 (in case you hadn't noticed). The girl is not Suzy.—Ed

*Clarence L. Johnson, "Analog Computer Techniques".

**Coordinate Systems and Methods of Coordinate Transformations for Dimensional Flight Equations", R. M. Howe, University of Michigan, in "Proceedings of First Flight Simulation Symposium, White Sands Proving Ground, New Mexico," November 1956.

Harold Ehlers (Autonetics, Downey, Calif.), *Bud Schoenber* (Aeroneutronics), *Gil Gramza* (Douglas Aircraft, El Segundo, Calif.), and *Len Schulwitz* (Hughes Aircraft, Culver City, Calif.). Pete's notes also indicate that the subjects discussed were the usual ones of interest to those responsible for maintenance (performance standards, test boards, optimum extent of daily check, etc.).

DDA Techniques

Irwin Pfeffer (Space Technology Laboratories, Los Angeles 45, Calif.) led 11 people in a discussion of "Analog-Digital and Digital Differential Analyzer Techniques", which he began with a description of the Space Technology Lab operation. Some other points brought out: A T-2V DDA was used in a Douglas plane for navigation computations in real time; the Naval Ordnance Lab would like to simulate kinematics digitally in real time. They have a Litton Industries DDA which they have not yet tied in, but they would like to gradually replace their analog equipment with it.

A request by Irwin for better DDA literature for analog people led to a discussion of the kind of problems done on analog computers as contrasted to DDA's and some tutorial information on DDA's, including an explanation of the difference in operation of serial and parallel DDA's.

The discussion next turned to the subject of analog-digital, digital-analog conversion equipment and the speeds and accuracies required.

The GEVIC computer was discussed, the generation of sine waves and other functions on DDA's was considered, and the discussion concluded with the suggestion by *Warren Shepard* (Litton Industries) that the next study-group session include a discussion of "Error Analysis of Sampled Data Systems", which is in line with the subject of the March meeting of the WSC, "Simulation of Sampled Data Systems".

Physical Simulation

Willard Uplinger (Pacific Missile Range,* Pt Mugu, Calif.) led the group on "Physical Simulation". He defined the subject as the closed-loop tie-in of computer and system hardware, described the use at PMR of the Bendix flight table, and then passed the subject around the table. The Hughes contingent (*Chuck Bertuch*, *Bruno Ulrick*, and *Hans Meissinger*) have used physical simulation mostly in connection with infra-red studies. They spent some time at the Kodak infra-red facility, but feel much more time is needed and that a facility at their plant would be desirable.

L. K. Koski (North American Aviation) said that they plan to use their Bendix flight table to study the damping system of the X-15 if they can get it to operate satisfactorily for the purpose.

Dick Blosser (Firestone Missile) said they used physical simulation for quality control and improvement throughout the Corporal missile contract. For this work they found it necessary to build special-purpose equipment to simulate the air-loads on control surfaces.

Solution Checking

Bill Kindle (EAI Computation Center, El Segundo, Calif.) led off the discussion of "Accuracy and Checking of Solutions" by describing static and loop-gain checks used at the EAI Computation Center. For the static checks they assume initial conditions for *all* variables, compute the voltages at all outputs from original physical equations, check these against values read from the computer, and correct any resulting deviations. They make the loop-gain checks by leaving all coefficients in a problem mechanization in algebraic form. Then the scale factors around all closed loops should cancel to unity. This is true for non-linear as well as linear loops. However, this is a diagram check, not a computer check.

Dick Seferian (Rocketdyne, Canoga Park, Calif.) brought up the question of specifying accuracy of solutions.

R. C. Schmidt (Beckman Instruments, Berkeley Div. Richmond, Calif.) and others discussed the relationships of accuracy to problem types and computation techniques. The concensus of opinion was that general specifications for solution accuracy are not feasible.

Paul Williams (Northrop Aircraft) said they use a static check procedure of applying initial conditions one at a time. Prior to inserting the initial conditions, tables are constructed showing the influences of each variable on every other one by inserting unit values (one at a time) for each, and computing the corresponding value of all others. This results in a large table which gives the voltage for all points in the computer versus integrator initial conditions. The table has many zeros.

*Howdoyalikethat? When I gave the best (?) nine years of my life there it was enough that it was the Naval Air Missile Test Center!—Ed

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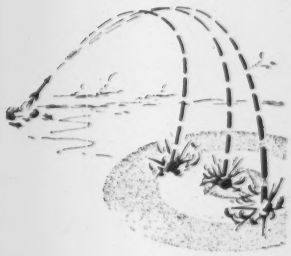

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SIMULATION COUNCIL

Ken Dyda (North American Aviation) brought up the subject of dynamic checking; North American effectively combines static and dynamic checks by using the IBM 704 to compute the static check and a sample time solution. They then overlay the analog and digital solutions on a light table. The digital program includes various cases with different nonlinear coupling terms omitted. This technique is used primarily for aircraft dynamics. Ken estimates that 20% of the errors found in the time solution would not have turned up in static checks.

CENTRAL STATES S/C MEETING OF 2 FEB

The Central States Simulation Council held a meeting at the Phillips Petroleum Company in Bartlesville, Oklahoma on 2 February 1959. According to notes sent us by *Charles Halijak* (Kansas State College, Manhattan, Kansas), who is Secretary-Treasurer of the group, the technical program consisted of the following papers:

"Philosophy of Computer Control" by *R. H. Jones* (Standard Oil Co. of Ohio). Discussion of the problems and difficulties of applying computer control to both existing and future processes. Areas in need of more work were outlined.

"A Numerically Controlled Milling Machine", *L. S. Austin*, (McDonnell Aircraft Corp.). Brief review of the application of numerical control to a milling machine; highlights of economic advantages, time savings, and machine accuracies.

"The Application of a Data-Handling System to Petrochemical Processes", *G. L. Smith* (Phillips Petroleum Co.). Brief résumé of several factors pertaining to the Phillips data-logger installation at the Sweeny Refinery. Digital tabulation of vast amounts of clear, concise, process information is the first step toward increased plant efficiency and control optimization. Use of automatic data-logging equipment for presentation of the essential process variables makes it possible to feed the information directly to computers for automatic material balance, yield accounting, operating guides, and engineering data calculations.

"Analog Computers in the Process Control", *J. F. Pink* (Southwestern Industrial Electronics Company). Brief comparison of analog and digital techniques for use in plant processes. Several types of application for analog computers were described, and examples given. Description of the first all solid-state passive component process analog computer.

"An Analog Computer for On-line Control of a Chemical Reactor", *E. D. Tolin* and *D. A. Fluegel*, (Phillips Petroleum Co.). Design and operation of an on-line analog computer for application to automatic control of a chemical reactor. Production rate of the product is derived from heat balance calculations, and the instantaneous concentration of product in the reactor is computed.

Information (Without Theory)

In our November issue of the *Newsletter* we reported that we had received a copy of a book on analog computers which, so far as we could tell, seemed to be a French Korn & Korn.

This elicited a letter from *R. H. Scanlan* (Schlumberger Well Surveying Corporation, Houston, Tex.) saying that he had spent some years in France and would be happy to review the book if we wished.

We wished, he did, and so herewith Mr. Scanlan's review of *Le Calcul Analogique par Courants Continus*:*

In this book Danloux-Dumesnils, professor at the National Superior School of Aeronautics, Paris, organizes the course of lectures which he gives at that institution. In his introduction the author protests almost vehemently in favor of the preservation of purely French terms in French analog computation work (as against the introduction of Anglicisms) yet he defends his own use of such un-French terms as "computeur" and "computage".

The real subject of the book is analog computing by d.c. electrical differential analyzer techniques. However, the title implies greater generalities, and acknowledgement is made of the existence of other techniques, notably special-purpose machines such as simulators, and potential field plotting devices and their derivatives.

After what are essentially opening barbs and/or amenities, the book settles down to a rather explicit exposition of its basic subject matter. It is a fairly straightforward course and certainly a potentially valuable one to newcomers in the field. The following are the chapter headings: I Mechanical calculation. II Principles of electrical computing. III Components and accuracy of the computer. IV Solution of linear algebraic systems. V Linear differential systems. VI Operational language and compound operators. VII Non-linear calculation. VIII Special calculating machines. IX Area of application of analog calculation.

Those chapters dealing more directly with the mathematics and techniques appropriate to the electrical differential analyzer are certainly the most valuable of the book. The chapter on solution of simultaneous equations by analog methods appears to the reviewer to present weak and rather ineffectual means when compared to those now offered by digital computers.

Although a number of specific analog machines are cited, the book deals with principles and generalities, not details of analog computer construction. The level is that of a senior or elementary graduate course in engineering. It would be of value to readers of French, but this reviewer would suggest a revision of subject matter should translation for the English-reading public be decided upon—particularly with the air of eliminating elements not important to d.c. differential analyzer type computing.

*Dunod, Editeur, 92, Rue Bonaparte, Paris.

He Went Thataway:

Tom Connolly (formerly with the Princeton Computation Center, EAI) to the Marine Division of Sperry Gyroscope in Syosset, New York.

Computer Events

Central Simulation Council

Date: 11 May 1959
Place: Kansas State College, Manhattan, Kansas
Subject: "Non-Linear Control Systems"

For further information write Charles Halijak at Kansas State College.

Central Simulation Council

Date: 5 October 1959
Place: McDonnell Aircraft Co., St. Louis, Missouri
Subject: "Computer Administration, Environments, and Physical Facilities."

For more information write Bruce H. Estes, Department 666, McDonnell.

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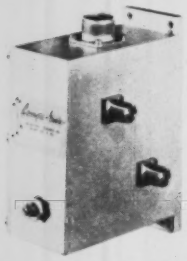

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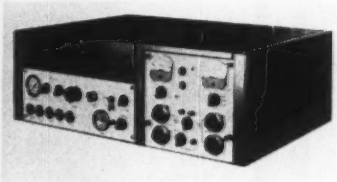
New Chroma-Lab 15-920 Combination Analyzer employs both thermal conductivity and catalytic combustion detection systems for gases and vaporizable liquids in the same instrument. Controls and gas connections are on the instrument face.—*Davis Instrument Div., 45 Halleck St., Newark, N. J.*



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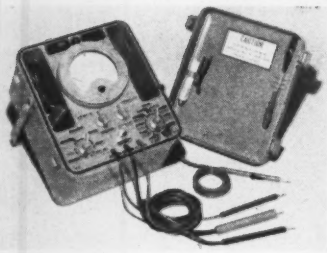
PRECISION MULTIMETER



New Type 245 portable Precision Electronic Multimeter (the equivalent of the Military TS-505D/U multirange meter), is used for measuring rms values of a-c voltages from 0.250v; d-c voltages from 0 to 1000 v, and d-c resistance from 0.2 to 1000 megohms. Included is an R-F adapter. —Spec Sheet 1032 contains details.—*Anton Electronic Labs., Electronic Div., 1226 Flushing Ave., Brooklyn 37, N. Y.*

For more information circle **187** on inquiry card.

DATA INTEGRATOR

New Data Integrator accepts fixed information from punched cards and variable data from its keyboard. These items are automatically combined in a single block and translated together onto punched tape. The tape, containing both types of information (fixed and variable), is immediately ready to be fed into computers, tape-to-card, or tape-to-tape converters and then to high-speed computers.—*Taller & Cooper Div. of American Electronics, Inc., 665 W. Washington Blvd., Los Angeles 15, Calif.*

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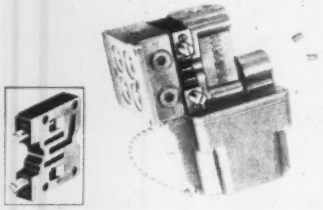
SPEED-CONTROL VALVE



New Speed Control Section, which can be installed as an integral part of any Series "CC" directional air control valve, gives accurate control of cylinder piston speeds by independently metering exhaust flow from both ends of an air cylinder through a single exhaust port in the valve. Can be factory installed on new Series "CC" valves, or ordered in kit form for installation on valve in service.—*Hannifin Co., Dept. 410, Div. of Parker-Hannifin Corp., Des Plaines, Ill.*

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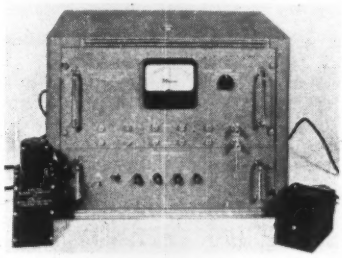
ELECTROSTATIC VOLTMETER

New 107-Series Feedback Electrostatic Voltmeter makes possible accurate drift-free measurements of the



voltage of an electrostatically-charged surface, without physical contact and essentially independent of variations in probe-to-surface spacing. An audio-visual alarm device permits monitoring of hazardous atmospheres encountered in surgery, mining operations, manufacture of explosives. etc. —*Monroe Electronic Labs., Inc., Middleport, N. Y.*

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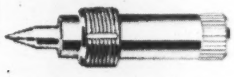
NEEDLE VALVE LOCK

New process, consisting of grooving a root-deep axial slot in the threads of a needle valve and filling this slot



with a plastic or metallic resilient material, provides positive adjustment and makes needle valves vibration resistant.—*Long-Lok Corp.*, 2601 *Colorado Ave., Santa Monica, Calif.*

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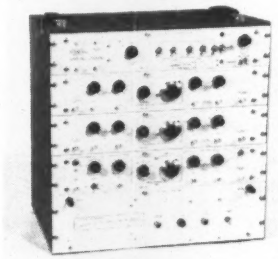
PULSE GENERATOR

New Model 2120A Precision Pulse Generator, featuring printed circuit construction, produces accurate, fast-rise time, low-impedance pulses for a



wide range of laboratory and test applications. Direct-coupled output assures operator that the output pulse baseline is at chassis ground and step attenuation controls preserve full waveform fidelity at all settings.—*Electro-Pulse, Inc.*, 11861 *Teale St., Culver City, Calif.*

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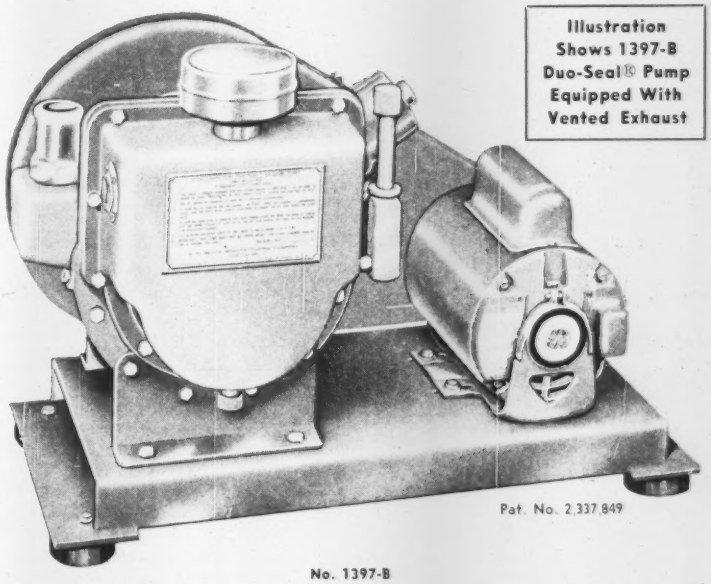

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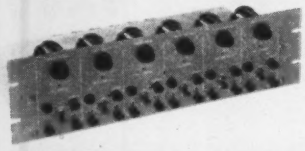
NEW INSTRUMENTS

RANGE AND BALANCE CONTROL

New adjustable BR 111 Range and Balance Unit that balances out small inequalities in bridge arm resistances features gold contact relays which



minimize "dry-circuit" problems. Built to withstand adverse environmental conditions, it contains six independently-adjustable identical channels, constructed on a single chassis for mounting in standard 19" racks. The unit is designed as a control center for use in coupling strain gages or resistive-bridge-type pickups to direct-writing oscillographs, standard meters, chart recorders and analog-to-digital converters.—*Computer Engineering Associates, Inc., 350 North Halstead, Pasadena, Calif.*

For more information circle **193** on inquiry card.

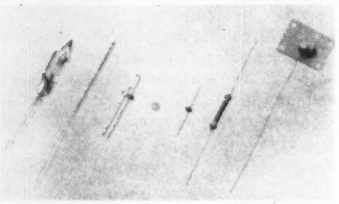
SILICON POWER RECTIFIERS

New line of Power Rectifiers with diffused-silicon junctions and epoxy has low forward drop; good reverse characteristics at all temperatures; and high insulation resistance. Current ratings of up to 25% higher than other rectifiers of similar size and cost are claimed.—*Vickers Incoroporated, Electric Products Div., 1815 Locust St., St. Louis 3, Mo.*

For more information circle **194** on inquiry card.

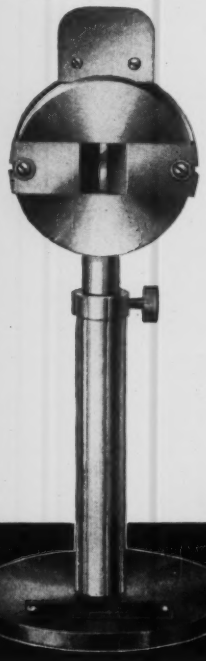
MATCHED THERMISTORS

New line of interchangeable and close-tolerance Matched Thermistors has more than 30 net units classified



in 5 major groups: (1) resistance matching, (2) voltage matching, (3) series-parallel matching, (4) resistance-temperature matching and (5) resistance ratio-temperature matching.—*Victory Engineering Corp., 534 Springfield Rd., Union, N. J.*

For more information circle **195** on inquiry card.



EPLAB

Thermopiles

For many years the thermopile has been the accepted instrument for measuring Radiant Heat from Radiant Heaters at the American Gas Association Testing Laboratory in Cleveland, Ohio. Since 1930, when Vandaveer first described his work in this field,* an Eppley thermopile has been used for this purpose in hundreds of tests and the results have been consistent and accurate to within 1 per cent.

This is but one of many applications in the field of radiant energy measurements for which Eppley Thermopiles are ideally suited. They may be obtained with windows of different materials, and various types of black are available for receiver coatings.

All Eppley Thermopiles are supplied with a certificate of calibration, this calibration being made against a Standard Lamp from the National Bureau of Standards.

If you have a problem involving the measurement of radiant energy we invite you to write us, describing your problem in as much detail as possible. We will be glad to make recommendations and there will be no obligation.

*Vandaveer, Industrial & Engineering Chemistry, Vol. 22, page 596, June 1930.

BULLETIN No. 3 ON REQUEST—Address: 2 Sheffield Ave., Newport, R. I.

THE EPPLEY LABORATORY, INC.
SCIENTIFIC INSTRUMENTS
NEWPORT, RHODE ISLAND, U. S. A.

For more information circle **80** on inquiry card.

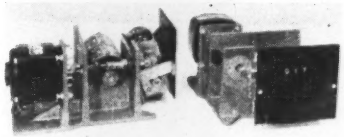
MINIATURE PROXIMITY PICKUP

New water- and oil-proof Miniature Proximity Pickup, for use while submerged or on machines using coating oils or coolants, is made in two models: Model 4913-WPN has a cable terminated with a 3-pin connector; and Model 4913-WPL has a cable with terminal lugs for connection to proximity control units having Cinch-Jones barrier-type terminal strips. They are able to detect both ferrous and non-ferrous metal parts having a diameter of less than 0.1", and can be excited by gear teeth of 10 diametral pitch.—*Electro Products Labs., 4500 N. Ravenswood Ave., Chicago 40, Ill.*

For more information circle **196** on inquiry card.

SERVO ASSEMBLY

New Servo Assembly, for use by designers of automatic null-balance systems, includes a Holtzer-Cabot 4-pole 60-cycle servo motor, drive coupling, shaft, bearings and gear drive assembly, digital counters with automatic shutter action to indicate plus or minus digital output, and one or more balance or output potentiometers. Synchro output and/or a Coleman Decimal Digitizer are also provided as optional equipment.—*Datran Electronics, 1836 Rosecrans Ave., Manhattan Beach, Calif.*



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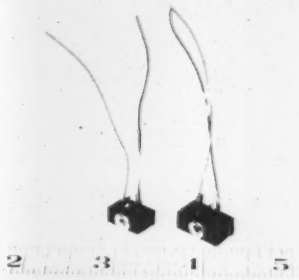
STABILIZED RECTIFIERS

New copper-oxide Instrument Rectifiers which are completely enclosed in a phenolic housing for high moisture, humidity, and salt spray resistivity, utilize helical springs to insure minimum change of characteristics with temperature.—*Edal Industries, Inc., 64 Franklin St., New Haven 11, Conn.*



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". . . . a practical text . . . covers fundamentals, basic bridge circuits, typical applications, and surveys typical commercial instruments which use or are used with strain gages."

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Capacities: M-100T, 100 scfm at 100 psig; M-30T, 30 scfm at 100 psig. Both models of rugged construction, require only 1 hour per year servicing.

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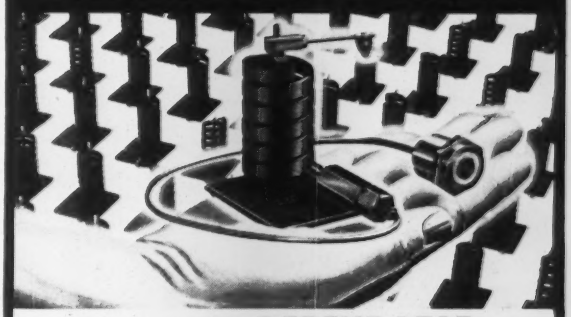

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For more information circle **82** on inquiry card.

Measure Resistance Quickly—Easily

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PORTABLE BRIDGES

Here are two bridges that are especially well suited for measuring resistances accurately when relatively unskilled workers must be used. And they're extremely handy for day-by-day measurements in the laboratory.

The Wheatstone Bridge covers a range of 0.05 to 50,000 ohms with only two knobs — a large scale calibrated from 0.5 to 50 and a smaller range selector with five positions: 0.1, 1, 10, 100 and 1000. A 4.5V battery provides power.

The Kelvin Bridge measures low resistances from 0.0001 to 2.1 ohms. Two dials, the larger calibrated from 0.0001 to 2.1 and a four position range switch provide readings.

For more information, write

ELECTRONIC EQUIPMENT DEPARTMENT
ELECTRONICS DIVISION
CURTISS-WRIGHT
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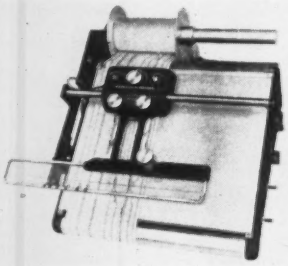
For more information circle **83** on inquiry card.

NEW INSTRUMENTS

DATA READER

New Electronic Data Reader facilitates the reading and scanning of oscillograms. Two rollers mounted in the rear run the recorded data either forward or backward over an illuminated scanning plate, at speeds which can be varied from zero to 200 ft/min.

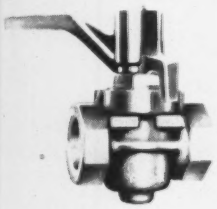


An electronic reading head represents physical distances (such as amplitudes and frequencies on oscillograms) as proportional voltages, by employing a voltage-dividing circuit consisting of two potentiometers connected in series. One potentiometer has a rack and pinion assembly attached to its shaft and divides the input voltage in proportion to its setting. The second calibrates or divides this proportional voltage to give the correct output voltage for an external readout device. Amplitude output is 0 to 10 vdc; frequency output is 0 to 10 vdc.—*Gerber Scientific Instrument Co., 89 Spruce St., Hartford 1, Conn.*

For more information circle **199** on inquiry card.

VACUUM VALVES

New line of Vacuum Valves is based on the principle that the plug, eccentric- or cam-shaped in cross-section, matches an eccentrically-raised body



seat. Tight shut-off is achieved by the eccentric action in combination with a resilient facing on the plug. (The leak rate across the seat on a 3" valve is certified at less than 0.003 micron cu ft/hour. Certified stem leak rate on valves 3" and smaller is 0.01 micron cu ft/hour. Valves, manufactured in sizes ½" through 20", are manufactured in a variety of materials. They can be supplied for manual operation or with on-off or positioning type actuators.—*DeZurik Corp., Sartell, Minn.*

For more information circle **200** on inquiry card.

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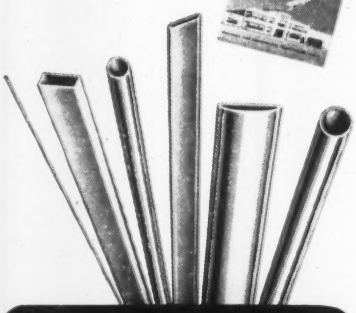
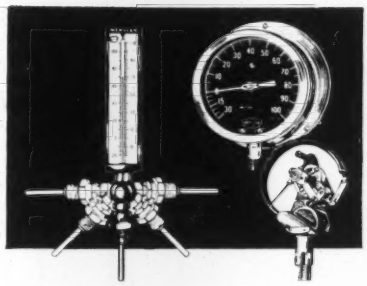


PRECISION TUBE COMPANY

For more information circle **84** on inquiry card.



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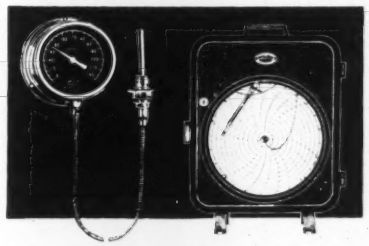

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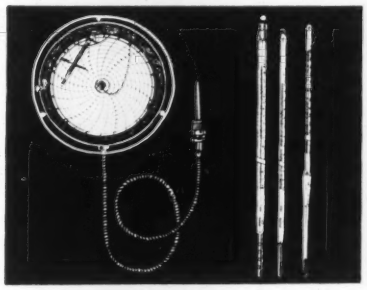

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For more information circle **85** on inquiry card.

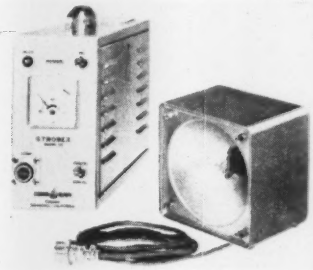
BE-CU SEAMLESS TUBING

New seamless tubing from beryllium copper No. 25 ranges from 0.010" O.D. to 0.625" O.D. and has wall thicknesses ranging from 0.042" down to 0.001" in the smaller sizes.—*Uniform Tubes, Inc., Collegeville, Penna.*

For more information circle **201** on inquiry card.

STROBOSCOPIC LIGHT

New Strobex Model 121 has a light so bright that it produces sharp strobe images even in normally-lighted rooms. Features are unusually high

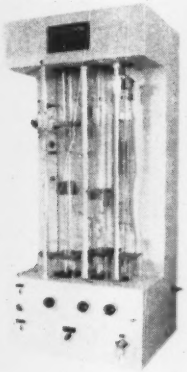


and flicker-free light output of 10 candle-sec/flash up to 100 flashes/sec; broad illumination angle of 50°, and an easily-replaced, low-cost flash tube with a life of over 36 million flashes. For still or movie photography, the illumination is 50 c-s/f, giving a guide number of 15.—*Chadwick-Helmuth Co., 472 East Duarte Rd., Monrovia, Calif.*

For more information circle **202** on inquiry card.

FLOW RATE CALIBRATOR

New volumetric-displacement Stand is for calibrating small flow devices to accuracies within 0.2%. System employs a unique "free-piston," operat-

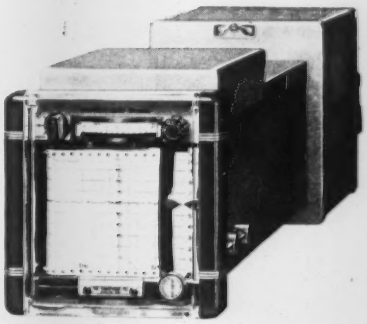


ing in a straight wall precision-bore glass tube as a collecting chamber. A groove around the circumference of the piston is filled with mercury to form a perfect and virtually frictionless seal between the glass tube and the piston.—*Brooks Rotameter Co., P.O. Box 432, Lansdale, Penna.*

For more information circle **203** on inquiry card.

AC
dc

this year more than ever in process control



The past year has been revolutionary. Electronic process control has won universal acclaim on every consideration: simplified installation . . . reduced maintenance . . . and, most important, better control performance. The evidence was so conclusive that other systems were totally ruled out on many new installations.

Swartwout pioneered electronic process control so Swartwout had a definite advantage: it was free to select the ideal circuit. AC in the measuring circuit has given unmatched simplicity and reliability extending the lengths and heights of the processing plant. DC is rightly used for the actuator. Experience has borne out the wisdom of this selection.

Moreover, Swartwout has shown that this vastly better control can be furnished without increased cost over pneumatic systems.

Send for Bulletin Series A-801. The Swartwout Co., 18511 Euclid Avenue, Cleveland 12, Ohio.

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ADAMS FACT FILE #3

INSTRUMENT AIR

Clean Dry Air Supply Will Reduce Production Down-Time . . . Instrument Maintenance . . .

Wet, dirty compressed air has no place in the process industries. In instrument air supply lines it can cause havoc. Whether it be motor air in a control circuit or supply air to the control panel, absolutely clean dry air is vital. Moisture elimination is the major consideration in providing suitable air for instrument and control systems.

Since most plant compressors in use today are oil lubricated, a finite amount of oil is present with the water vapor in the discharge. This carry-over condenses as an oil-water emulsion which often causes serious fouling of instrument components. To eliminate this oil-moisture condensate in the air lines, it is necessary to remove it before it reaches the distribution system. This is done by cooling the air before the receiver. It is advisable to cool well below the ambient conditions to provide the lowest possible humidity at the instrument panel or control units.

Two Stage System Design for Economy

The ideal method to achieve high quality air is a two-step operation.

1—An Adams Aftercooler . . . providing 2° F. cooling . . . and Cyclone Separator installed between the compressor and receiver to remove the bulk of moisture carry-over.

2 — A chemical dryer installed down stream to provide the polishing action necessary for the desired minimum humidity.

Thus, the bulk of water . . . 90% . . . is removed by the Aftercooler-Separator using plant water for cooling. A minimum moisture load is then left to be removed by more expensive methods. Under normal circumstances, all of the oil present in the compressor discharge will be removed in the Aftercooler-Separator. Fouling of the chemical unit is then virtually eliminated.

Poro-Stone Air Filter at Panel Provides Dirt-Free Control Air . . .

In spite of the efficiency of the Adams Aftercooler and Separator, there still will be some dust and dirt present in the instrument air system. That's why it is advisable to install an Adams Poro-Stone Air Filter in the line just before the control panel.

Separation by the Adams unit is in two stages — centrifugal and diffusion. Centrifugal force throws the foreign matter to the walls of the filter body where it is trapped in slots and drained. Remaining particulate matter is removed as the air passes through the pores of the Poro-Stone element.

This final protection for your instruments will minimize control system failures and process down-time. Instrument maintenance will be sharply reduced.

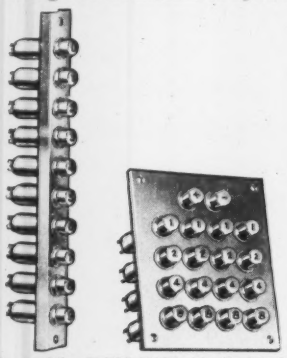
Literature Will Help Air System Design

For further information on how the complete line of Adams air equipment can help you provide a foolproof instrument air supply, write today for your copy of Bulletin No. 712 on Aftercoolers and Separators and Bulletin No. 117 on Poro-Stone Air Filters to the R. P. Adams Company, Inc., 265 East Park Drive, Buffalo 17, New York.

For more information circle **87** on inquiry card.

DATA STRIP

New Data Strip provides a number of ultra-miniature indicator lights for mounting in a minimum of space. Da-



ta Strip No. DSV-7538-10 (left) holds 10 lamp holders. (Data Strips can be made with any desired number of lampholders on the aluminum channel for vertical or horizontal reading. The Data Matrix (right) is similar to the Data Strip but rectangular in shape. No. DM-7538-18, a typical binary computing application, holds 18 lampholders.—*Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y.*

For more information circle **204** on inquiry card.

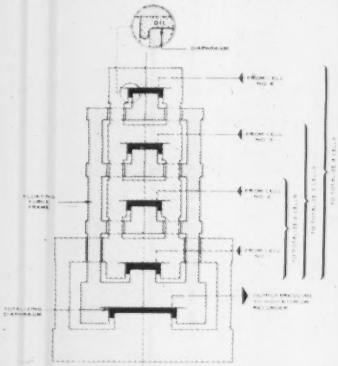
LOW-LEVEL D-C AMPLIFIER

New Model EM-2000A, a completely transistorized d-c Amplifier, is a chopper amplifier not of the magnetic- or mechanical-chopper types with high frequency response and power requirements of less than two watts. Multiplexing can be done at the amplifier input, thus permitting the use of one amplifier instead of many.—*Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J.*

For more information circle **205** on inquiry card.

HYDRAULIC LOAD TOTALIZER

New Way-Pac Load Totalizer for combining the loads of two to four hydraulic load cells is self-contained



WAY-PAC LOAD TOTALIZER

and has a sensitivity of 1 part in 5,000. Unit accepts the maximum capacities of both the 1,000-lb and 5,000-lb cells.—*A. H. Emery Co., New Canaan, Conn.*

For more information circle **206** on inquiry card.

Outstanding Accuracy

PALMER

Dial Thermometer

Check these functional features

- Direct-drive Bourdon Coil with a filled system for longer lasting accuracy.
- Stem can be placed at any desired angle and case can be rotated to most readable position.
- External calibration for zero setting.
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- Non-corrosive case.

PALMER

THERMOMETERS, INC.

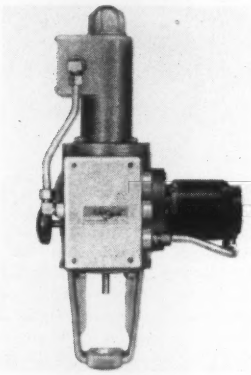
Mfrs. of Industrial Laboratory, Recording and Dial Thermometers

2515 Norwood Ave., Cincinnati 12, O.

For more information circle **88** on inquiry card.

ELECTRIC ACTUATOR

New all-electric Actuator, Model D-62XW, provides automatic or remote-manual positioning for proportioning control of many types of valves, dampers, louvers, metering pumps, and speed changers. It can

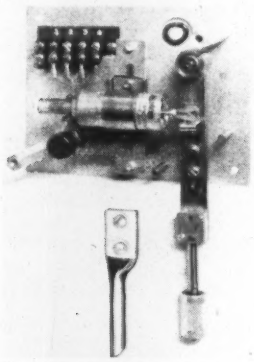


also be used for on-off remote push-button control with optional position indication. Available travels are from ½" to 4", with a maximum thrust of 700 lb. Stroking speeds are from 8.5" min at 100 lb load to 2.5" min at 700 lb load. Integral positioning stem and mounting yoke make the Model D-62XW especially suitable for field mounting.—Bulletin D-62-1 gives details.—*Conoflow Corp.*, 2100 *Arch St., Phila. 3, Pa.*

For more information circle **207** on inquiry card.

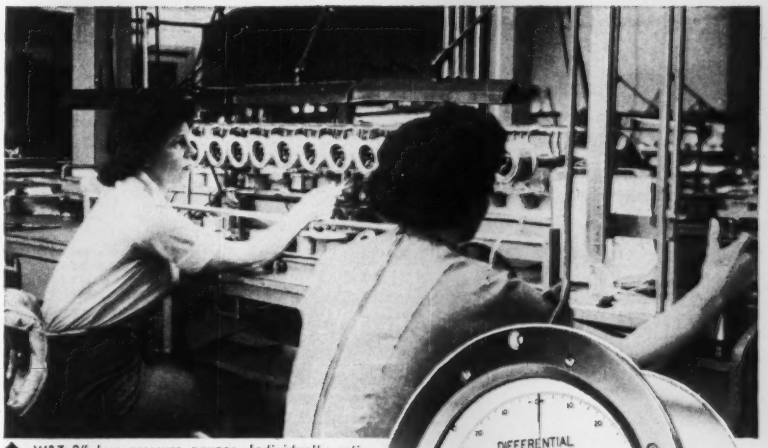
ELECTRONIC EDGE CONTROL

New Edge Guide Control System, which exerts only ¼ oz pressure in sensing edge position of moving strips or sheets of paper, textiles, oilcloth,



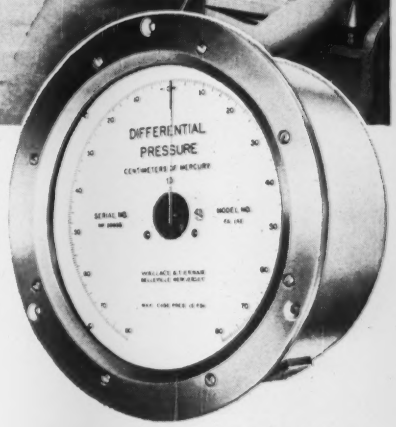
glass, metals, etc., is capable of corrective positioning to within 0.001". The mechanical pickup is connected to a servo-controlled hydraulic system wherein an output signal is fed through an electronic amplifier to a servo motor positioning a hydraulic valve.—*Automatic Timing & Controls, Inc., Dept. 211, King of Prussia, Penna.*

For more information circle **208** on inquiry card.



▲ W&T 3" low pressure gauges, individually calibrated, are checked against a precision standard.

A 6" gauge for easy readout is also available. ▶



PRESSURE MEASUREMENTS WITH PRECISION

W&T low pressure gauges bring 0.3% accuracy, rugged portability to your job

Calibration checked and double-checked . . . so you know the gauge is right when you record a reading. And W&T pressure gauges stay accurate in spite of rough handling. You can use them right on the job—still have laboratory accuracy.

These gauges are in stock now. For information write Dept. A-122.48

service: gauge pressure; differential pressure; vacuum determinations; or as compound pressure-vacuum gauges with zero center; **accuracy:** 1 part in 300; **sensitivity:** 1 part in 500; **minimum range:** 0 to 10 inches H_2O; **maximum range:** 0 to 400 inches H_2O; intermediate ranges of pressure or vacuum in any pressure equivalent are also available.

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25 MAIN STREET, BELLEVILLE 9, NEW JERSEY
IN CANADA: WALLACE & TIERNAN LTD., WARDEN AVE., TORONTO 13, ONT.

W&T MERCHEN SCALE FEEDERS & METERS

for Automatic Batch Control
Continuous Blending
Materials Accounting

Control the feeding of ingredients by weight to an accuracy of 1%.
Capacities range from 3 to 3000 lbs. per min.

WRITE FOR YOUR COPY OF OUR BULLETIN: M-31.48
"The Best Weigh is the Merchen Way."

WALLACE & TIERNAN INCORPORATED
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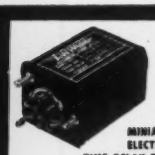
For more information on Pressure Gauges circle **89** on inquiry card.
For more information on Scale Feeders circle **90** on inquiry card.

RUGGED and RELIABLE
New!
TRANSISTORIZED
The A. W. HAYDON COMPANY'S TRANSISTORIZED SUB-MINIATURE ELECTRONIC TIME DELAY RELAYS!


MINIATURE ELECTRONIC TIME DELAY RELAYS 31200 SERIES

SUB-MINIATURE ELECTRONIC TIME DELAY RELAYS 31300 SERIES

SAVE SPACE AND WEIGHT!

	Miniature Series	Sub-Miniature Series
Cross Section	17/16" x 121/32"	31/32" x 13/16"
Length	2¼" long	2" long
Weight	6 ounces	3 ounces
WRITE FOR:	Bulletin AWH TD-503	Bulletin AWH TD-504

TEST-PROVED PERFORMANCE!
High Temperature: 125°C (250°F)
Vibration: 2000 CPS at 15 g.
Contact arrangements up to 4 pole double throw.
Unique transistorized R.C. time constant network.
Time Delays from 50 MS to 120 seconds. Longer Delays available.
Hermetically sealed housings.

MEET REQUIREMENTS OF MIL-E-5272A.

The A.W. HAYDON Company
228 NORTH ELM STREET, WATERBURY 20, CONNECTICUT
Design and Manufacture of Electro-Mechanical Timing Devices

See us in Booths 2702-2704 at the 1959 IRE Show.
For more information circle 91 on inquiry card.

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INDUSTRIAL • SCIENTIFIC • PHOTOGRAPHIC

I PRECISION OPTICS
WINDOWS • PRISMS • WEDGES

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ON ALL TYPES OF GLASS & CERAMICS

N PRECISION OPTICAL MACHINING
METAL LENS MOUNTS • BARRELS • EYEPIECES

AUTOMATIC SCREW MACHINES TO 4" DIA. — ALSO HAND SCREW MACHINES — ENGLISH & METRIC THREADS OUR SPECIALTY.

Write for Filter Transmission Curve Catalog.

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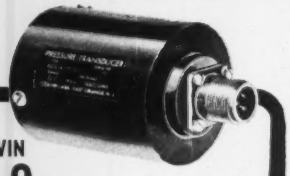
For more information circle 92 on inquiry card.



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HI-G PRESSURE TRANSDUCERS

- For Absolute, Differential or Gage Pressures.
- Small Size — Light Weight.
- Withstand 25g to 2000 cps.
- Outputs Linear With Pressure, Air Speed and Altitude.
- Accurately Dependable for Missile and Other Airborne Pressure Measurement Applications.

For complete technical information, write:

COLVIN LABORATORIES, INC.
364 Glenwood Avenue, East Orange, N. J.

For more information circle 93 on inquiry card.

NEW INSTRUMENTS

TIMING MOTORS

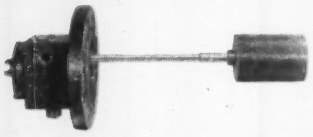
New line of Sychronous Timing Motors is made for 25-, 50- or 60-cycle operation in five standard voltage ratings. Series 22100 motors (illustrated)

meet MIL-E-5272A specs. The 42100 series is for high-volume industrial and commercial applications. Over 125 standard output speeds from 300 rpm to one revolution in six hours can be supplied with either standard or heavy-duty gear trains. Nominal running torque at 1 rpm is 30 oz in.—*The A. W. Haydon Co., Waterbury, Conn.*

For more information circle **209** on inquiry card.

FLOAT LEVEL-CONTROLLERS

New Mic-O-Flex positive-displacement type Float Switches, with synthane float incorporate the flexure-

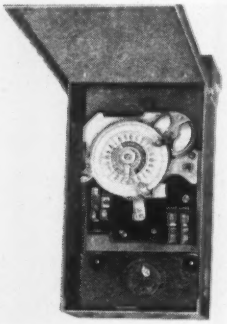


tube principle to provide accurate and dependable liquid level control. Shown is the Model CMEF-401.—Bulletin MF-1158 contains additional information.—*Instruments, Inc., P. O. Box 556, Tulsa, Okla.*

For more information circle **210** on inquiry card.

TIME SWITCHES

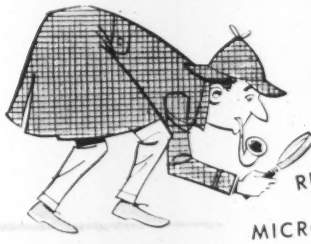
New line of heavy-duty Intermatic 55-series T500-R Time Switches will handle up to 27,500 watts of tungsten-filament (incandescent) lamp loads,



or motor loads up to 2 hp. Models are available for standard "on-off" operation, or with "Skipper" feature to eliminate operation on selected days.—*International Register Co., 2624 W. Washington Blvd., Chicago 12, Ill.*

For more information circle **211** on inquiry card.

FOR LEAK-DETECTION DEVICES



OHIO

NITROUS OXIDE

READILY DETECTS MICROSCOPIC LEAKS

Infrared determination of nitrous oxide provides a safe, sensitive and flexible method of leak detection. This method is not affected by usual atmosphere components such as moisture, carbon dioxide and hydrocarbons. In addition, nitrous oxide will not harm pieces being tested and is more economical than other gaseous agents.

OHIO NITROUS OXIDE: ODORLESS AND INERT • NONTOXIC • NONCORROSIVE • NONFLAMMABLE • ECONOMICAL

FREE TECHNICAL AID is available in the use of nitrous oxide for leak detection. For further information, please request the following bulletins:

1A Chemical, Physical and Pharmacological Properties of Nitrous Oxide with Results of Corrosion Tests

1B Gas Service Equipment for Nitrous Oxide Supply

OHIO *Ohio Chemical*

OHIO CHEMICAL & SURGICAL EQUIPMENT CO.
(A Division of Air Reduction Company, Incorporated) AIRCO
MADISON 10, WISCONSIN

For more information circle **94** on inquiry card.

Surface PYROMETERS

for every purpose

The routine use of CAMBRIDGE Surface Pyrometers takes the guesswork out of temperature determination in many industries. The CAMBRIDGE is accurate, dependable, rugged, quick-acting and easy to use. The Roll Model is for checking surface temperatures of moving rolls. The Needle Model is for insertion into materials in a plastic or semi-plastic state for batch temperature determination. The Mold Model is for checking surface temperatures of mold cavities and surfaces of almost any contour.

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PIONEER MANUFACTURERS OF

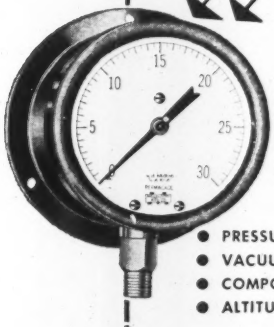
PRECISION INSTRUMENTS

Moisture Indicators and Recorders • Physical Testing Instruments Laboratory Instruments for A.C. and D.C. • Galvanometers • Engineering Instruments • Gas Analysis Equipment • Physiological Instruments and many other Mechanical and Electrical Instruments

For more information circle **95** on inquiry card.

MARSHALLTOWN

THE RIGHT GAUGE FOR YOUR SPECIFIC NEEDS



Available in a wide variety of general purpose and special purpose gauges in pressure ranges to meet your specifications in every particular.

- PRESSURE
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- AND SPECIAL PURPOSE GAUGES
- DIAL THERMOMETERS (Vapor Tension or Bi-Metal)

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For more information circle **96** on inquiry card.

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HIGH FREQUENCY *Induction* HEATING

HARDENING
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LEPEL Electronic Tube GENERATORS—1 KW; 2½ KW, 5 KW; 10 KW; 20 KW; 30 KW; 50 KW; 75 KW; 100 KW.

LEPEL Spark Gap Converters 2 KW; 4 KW; 7½ KW; 15 KW; 30 KW.

WRITE FOR THE NEW LEPEL CATALOG . . . 36 illustrated pages packed with valuable information.

All Lepel equipment is certified to comply with the requirements of the Federal Communications Commission.

LEPEL HIGH FREQUENCY LABORATORIES, INC.
55th STREET and 37th AVENUE, WOODSIDE 77, NEW YORK CITY, N. Y.

For more information circle **97** on inquiry card.

New Clary Form Printer records data on pre-printed forms!

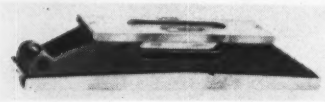
Now you can record data on a wide variety of pre-printed tickets, inspection forms, labels and tapes! You may put whatever headings you want on these forms, and the Clary Form Printer will automatically print data under the appropriate headings. This saves time and avoids recording errors, for it eliminates signature blocks and the need to write in on the recording document just what the data represent● In addition, this amazing device prints the original document and three copies...provides automatic ticket ejection to "tear-off" point...prints up to 12 digits of information per line at speeds up to 2½ lines per second...and is available with a separate date-printing mechanism, a sequential document-numbering system and an electrical output for tape punches and other recording devices● For more information on the Clary Model 1941 Form Printer, write today for Engineering Bulletin No. S-109●

For more information circle **98** on inquiry card.

NEW INSTRUMENTS

BLOCK LEVEL

New imported Precision Level incorporates several unusual features, such as side openings for vertical and



horizontal observation; bubble tube protection by cover plate which also acts as insulating grip; and adjustable ground bubble tube. Sensitivity is 2-3 sec, 4-6 sec and 10 sec of arc. Available lengths are 6", 8", 10" and 12".—*Opto-Metric Tools, Inc.*, 137 *Varick St., New York* 13, *N. Y.*

For more information circle **212** on inquiry card.

GEAR-MEASURING WIRE KIT

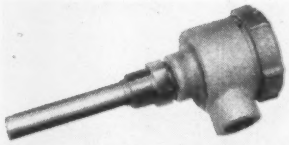
New Precision Gear-Measuring Wire Kit, BE-26, contain 23-, 32-, 48-, 64-, 72-, 96-, and 200-pitch

Measuring Wires and is available from stock.—*PIC Design Corp., Sub. of Benrus Watch Co., Inc.*, 477 *Atlantic Ave., East Rockaway, L. I., N. Y.*

For more information circle **213** on inquiry card.

THERMOSTAT

New explosion-proof Thermostat, UL-approved for Class 1, Group D hazardous areas, designed for convenient immersion in tanks, wall installa-



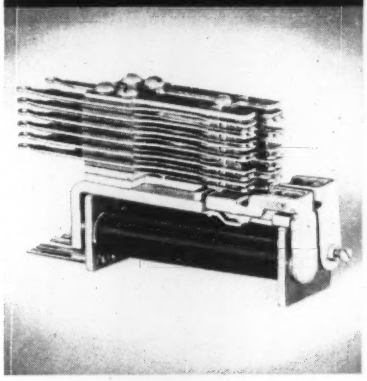
tion, and for exposure to contaminated environments, is made up of (1) a Series 47000 Thermostat unit, (2) stainless steel well, and (3) an explosion-proof junction box. Adjustable over a 32°F to 500°F range it can be exposed indefinitely to −100°F, or, for short periods, to 100°F above its set point.—*Fenwal Incorporated, Pleasant St., Ashland, Mass.*

For more information circle **214** on inquiry card.

Stromberg-Carlson

"TELEPHONE QUALITY"

Relays



. . . available immediately for any part of your operation that depends on electromechanical switching.

Proven by many years of meeting the exacting requirements of the telephone industry, these twin-contact relays of unsurpassed reliability are available in many types. The following are representative:

Type A: general-purpose relay with up to 20 Form "A" spring combinations. This relay is excellent for switching operations.

Type B: a gang-type relay with up to 60 Form "A" spring combinations. **Type BB** relay accommodates up to 100 Form "A" springs.

Type C (illustrated): two relays on the same frame. A "must" where space is at a premium.

Type E: has the characteristics of Type A relay, plus universal mounting arrangement. Interchangeable with many other makes.

Complete details and specifications on all Stromberg-Carlson relays are contained in our *new relay catalog*. Contents include: spring combinations, table of equivalents, contact data, variations and special features, plus complete mounting and cover information.

The catalog is available on request.

STROMBERG-CARLSON

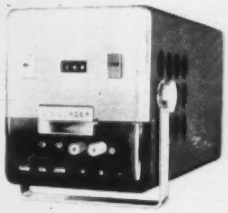
A DIVISION OF GENERAL DYNAMICS CORPORATION

Telecommunication Industrial Sales
113 Carlson Rd. • Rochester 3, N.Y.

For more information circle **99** on inquiry card.

DIGITAL MILLIVOLTMETER

New portable Series-A Digicorder measures millivolts accurately with both a digital visual indication and direct remote electrical readout. Scale

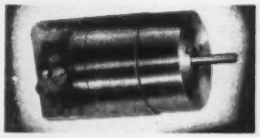


ranges include 0 to 10 mv, 100 mv, 1 v, 10 v, and 100 v without use of external amplifiers. Sensitivity is better than 2.5 uv, and an accuracy of 1 part in 1000 is retained in all models through the use of a built-in mercury standard cell. The instrument operates as an extremely linear self-balancing servo potentiometer, utilizing a chopper and a high-gain tuned amplifier.—2-page Bulletin 102 contains details.—*Computer Equipment Corp., 1931 Pontius Ave., Los Angeles 25, Calif.*

For more information circle **215** on inquiry card.

REVERSIBLE FHP MOTOR

New Universal Motor is available in several models, ranging from 6 to 48 v d-c or a-c input, and is rated at



1/75 hp for intermittent duty, or 1/125 hp for continuous duty. Overall dimensions are approximately 1-¾" dia by 3" long, plus the ¾" to 1" shaft extension.—*Carter Motor Co., 2704 A W. George St., Chicago 18, Ill.*

For more information circle **216** on inquiry card.

THERMO-REGULATORS

New Quick-Set Thermo-Regulators for precise air or liquid temperature control have Vernier-like adjustments which are made quickly and easily by

turning a 1" dia ring knob. Sensitivity is within ± 0.005°C. A totally glass-enclosed needle-like tungsten contact is raised and lowered in a hydrogen-filled mercury capillary by magnetic action. Temperature range is from −35° to +400°F.—*H-B Instrument Co., Inc., American & Bristol Sts., Phila. 40, Pa.*

For more information circle **217** on inquiry card.

offers the excellent electrical advantages of

TEFLON*

plus these important

SERVICES

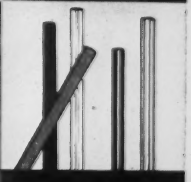
CUT TO LENGTHS YOU REQUIRE

REGIONAL STORAGE FACILITIES

PART NUMBER INDELIBLY PRINTED

RECTANGULAR TUBING TO ORDER

COLOR TUBING AND TUBING WITH AXIAL STRIPES



OVER-NIGHT DELIVERY

NOTE: PF TEFLON* advantages: good dielectric strength (500 to 1000 volts mil); lowest dielectric constant (2.0) and dissipation factor (0.0002) of any solid dielectric; no change of electrical properties with temperature (−25°C to +250°C) or frequency (60 cycles to 100 mc); zero moisture absorption; unaffected by any commercial chemical.

WRITE, WIRE OR CALL:

PENNSYLVANIA FLUOROCARBON COMPANY, INC.

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EVergreen 6-0603 • TWX PH 252

*TEFLON — du Pont trade name for tetrafluoroethylene resin

For more information circle **100** on inquiry card.

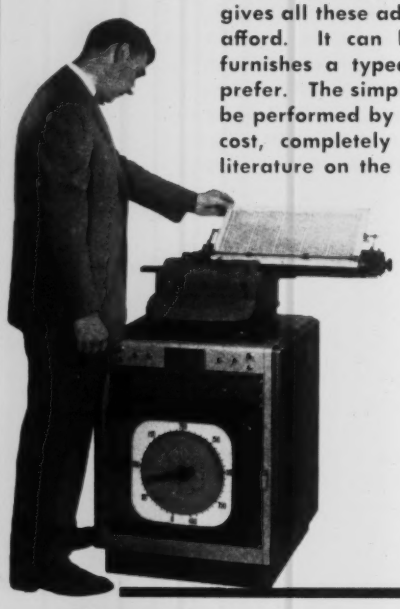
what price reliability in a DATA LOGGER?

$6800.* FOR A DATA-MASTER® THAT WILL DIGITALLY RECORD up to 50 points

A reliable data logger can automatically record your test or process data, and simplify your entire system. Day after day, through routine or emergency conditions, you get dependable data—free from human error. The need for re-tests is eliminated. And because it centralizes your data recording, you can release manpower for other duties.

Such a system is not expensive.

The reliable, time-tested Data-Master Logger gives all these advantages at a price you can afford. It can be hooked up quickly. It furnishes a typed record, or a tape if you prefer. The simple maintenance required can be performed by your own man. For a low-cost, completely reliable logger, write for literature on the DATA-MASTER.



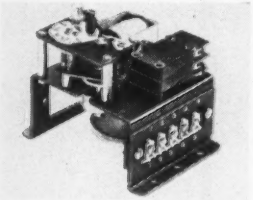
*Price is for thermocouple inputs, and includes linearizing circuits. Unit is complete and ready to use, in attractive console on casters, top-mounted typewriter. F.O.B. Glen Cove, N. Y. Standard Warranty included.

h-g-b HANSON-GORRILL-BRIAN, INC.
85 HAZEL STREET, GLEN COVE, N. Y.

For more information circle **101** on inquiry card.

TIME DELAY RELAY

New Type 471 Time Delay Relay provides an accurate adjustable time delay between the operation of a con-

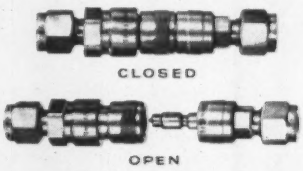


trol circuit and the subsequent transfer of one or two load switches. Time ranges are from 15 sec to 24 hrs. Adjustment range is from about 10% to 100% of full scale. Repeat accuracy is within 2%, reset time approximately ½ sec.—*Cramer Controls Corp., Centerbrook, Conn.*

For more information circle **218** on inquiry card.

QUICK-CONNECT FITTING

New Type of Quick-Connect Fitting with double-end shut off for pneumatic or hydraulic lines, has instant-

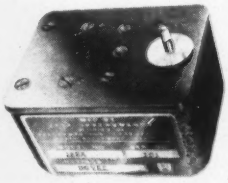


acting seals in both parts of the unit. Available in sizes for ¼" through ⅜" O.D. tube in steel, stainless steel and brass.—*Crawford Fitting Co., 884 East 140th St., Cleveland 10, Ohio.*

For more information circle **219** on inquiry card.

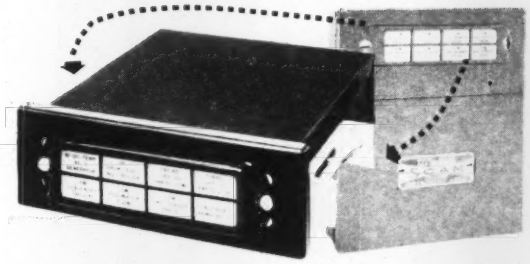
STEPPING MOTOR

New miniature stepping devices, the Neuron MotoStep, and the Neuron MotoSwitch are available in unidirectional and bi-directonal units. The MotoStep does not contain a stepping



switch. The stepping switch is a 10-point etched-circuit precision switch with plated contacts. The bidirectional feature is accomplished through the use of two identical stepping motors driving the same shaft in opposite directions. The output shaft is rotated 36° for each input impulse, up to 40 steps/sec. Both units are available in standard voltages of 24, 48 and 90 vdc, and 110 vac, and are so designed as to prevent double indexing.—*Data Instruments Div. of Telecomputing Corp., 12838 Saticoy St., North Hollywood, Calif.*

For more information circle **220** on inquiry card.



Model ST-FM

Now—Automation Control You Can Depend On!

NEW SCAMMIT

STATIC-SWITCHING

MONITORING SYSTEMS

MODEL ST-AM

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- **Self-Contained**
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- **Range of Models and Sizes**

Get greater reliability for all kinds of process and automation control with SCAMMIT MONITORING SYSTEMS. Permanent components and static switching reduce operational failure. Investigate dependable, economical SCAMMIT before you invest in any monitoring system.

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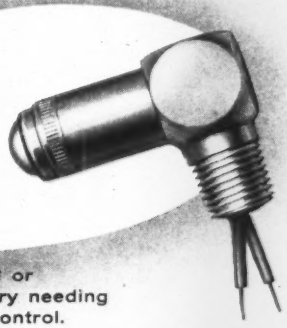
REPRESENTATIVES IN ALL PRINCIPAL CITIES

For more information circle **102** on inquiry card.

INDUSTRY-BY-INDUSTRY!

ESS Miniaturized "Electric-Eyes" are designed for automation applications.



- ☑ Cigarettes
- ☑ Government
- ☑ Drugs
- ☑ Pharmaceutical
- ☑ Cosmetic
- ☑ Packaging
- ☑ Printing
- ☑ Chemical
- ☑ Textile
- ☑ Beverage

—and any general or processing industry needing constant quality control.

For monitoring-counting-registration or control the ESS Miniaturized "Electric-Eyes" are engineered for the production line. These photomation instruments are rugged, compact and small enough to fit into "tight" places. Precise quality control by percentage cut-off of direct light **or** by reflected beam.

A special staff of engineers are ready to handle your problems. Prompt quotations and delivery. Write for descriptive bulletins.

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Photomation inc.

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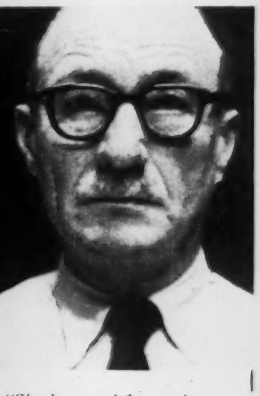
ELECTRONIC INSTRUMENTS and CONTROLS for INDUSTRY

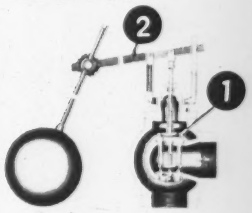
For more information circle **103** on inquiry card.

"Which type float valve do you need?"

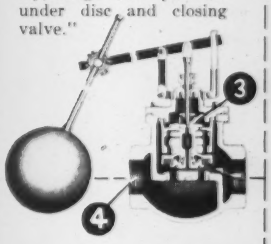


Here are some basic facts —taken from the Klipfel catalog*—which will help you decide.

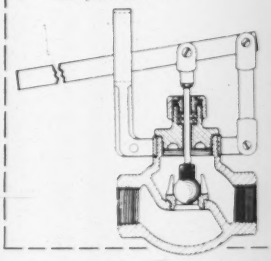
"To control liquid level in an open tank where tight closing is not essential, select a simple, direct acting, balanced float valve such as this Klipfel No. 27. Inner valve (1) opens as float drops. By reversing the lever (2), valve closes as float drops."



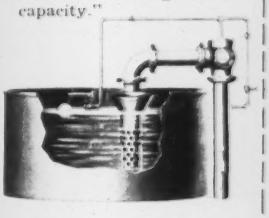
"Single seated float valves close tightly, prevent damage or waste from overflow due to valve leakage. Internal pilot action adds pressure of incoming liquid to buoyance of the float, keeping valve tightly closed. When pilot port (3) opens, water escapes through outlet (4). When it closes, pressure builds up above piston, equalling inlet pressure under disc and closing valve."



"This single-seated, all-metal float valve is ideal for tight closing with fluids injurious to rubber parts. Available in stainless steel or other corrosion-resistant materials to control levels of chemicals, fruit juices, etc."



"External-pilot-operated float valves use a small float valve in the tank to actuate a large main valve conveniently positioned outside the tank. This simplifies maintenance without reducing tank capacity."



***Much useful information on float valves and level control valves is available free in Klipfel Bulletin 254. Write on your company letterhead or ask for the complete catalog on all types of Klipfel automatic regulating valves.**

HAMILTON • OHIO Klipfel **VALVES, INC.**

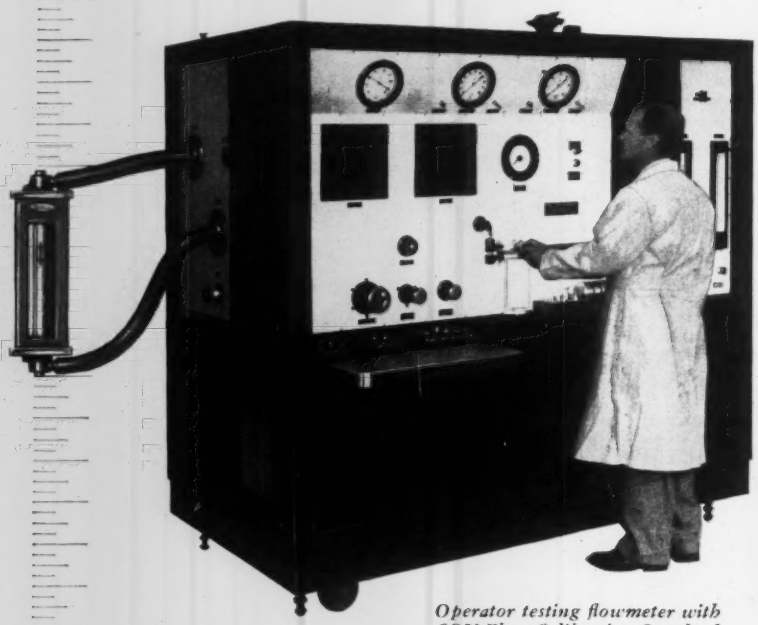
Automatic Temperature and Pressure Regulating Valves Since 1902

Float Valves • Temperature Regulators • Back Pressure Valves • Reducing Valves

A DIVISION OF THE HAMILTON-THOMAS CORPORATION

For more information circle **104** on inquiry card.

How UNION CARBIDE Verifies Flowmeter Accuracy



Operator testing flowmeter with COX Flow Calibration Standard

Periodic checking of liquid flowmeters at the huge Oak Ridge, Tennessee nuclear facility presented a problem to the Union Carbide Nuclear Company, operators of the facility. Checking the instruments required a known standard against which they could be evaluated. Using other flowmeters as masters was of questionable value as they too were subject to the same variables of wear, temperature changes, and viscosity shifts as were the instruments under test.

Union Carbide solved the problem by using a *COX Flow Calibration Standard* (Type 315), the same as those used by flowmeter manufacturers for original instrument calibration. It gives them a *primary standard* of their own — assuring accurate flow measurements that can be correlated with measurements by the National Bureau of Standards.

Costly? Not as much as you'd think for a *primary standard*. And the time normally spent on rechecking, evaluations, and analyzing test data was eliminated.

If you make or use flow measuring devices you will be interested in our new Technical Bulletin on *COX Flow Calibration Standards*. Write to: *Cox Instruments Division, George L. Nankervis Company, 15400 Fullerton Avenue, Detroit 27, Michigan.*

IF IT'S WORTH MEASURING
It's worth measuring accurately 7392

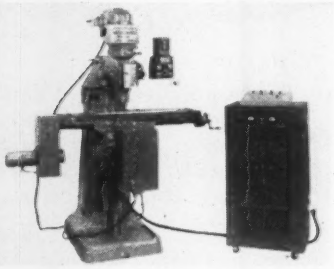
COX Instruments

For more information circle **105** on inquiry card.

NEW INSTRUMENTS

MACHINE TOOL AUTOMATION

New Micro-Path Control System, for low-cost machine tool automation, uses magnetic-tape control without computer programming equipment. The basic system can be applied to

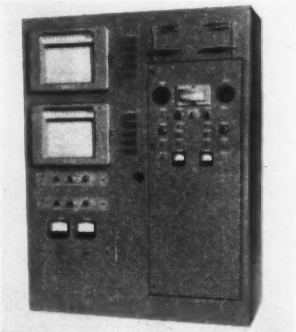


existing machine tools, can be designed into new machines, and can also be used for other control applications, such as transfer mechanisms, valve positioning, switch positioning, industrial drones, telemetering controls, etc. Advantages include accurate locating within ± 0.001" with fail-safe checks, and simple production of magnetic tape recordings by tracing the desired path on the machine in use.—*Micro-Path Inc.*, 4949 *W. 104th St., Inglewood, Calif.*

For more information circle **221** on inquiry card.

GAS CHROMATOGRAPHY

New basic sizes of gas-liquid chromatographic Ionization Detection Systems are for automatic separation, identification, and permanent record-



ing of different chemical substances. Model 10, (shown) is a laboratory system capable of either single- or dual-column operation using glass, metal, or capillary columns. Model 20, a portable system, uses capillary tubes. Ionization current is initiated by a small radioactive source. Accuracy is said to be superior to conventional devices which measure changes in thermal conductivity of a carrier gas stream contaminated with a sample vapor.—*Barber-Colman Co., Wheelco Instruments Div.*, 1300 *Rock St., Rockford, Ill.*

For more information circle **222** on inquiry card.

ONE FLICK RESETS this HIGH SPEED *Electric* COUNTER

Model "YE" by

DURANT

(Test count-life over 70 million)

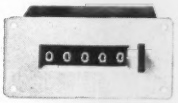
Offered in TWO STYLES:

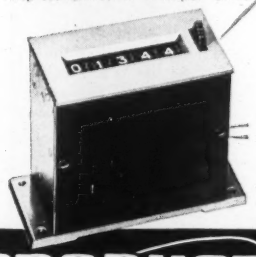
1. Quick PUSH-BUTTON RESET
2. Electric REMOTE RESET

First high-speed electrically actuated counters with added advantage of electric reset. Clean-cut, legible 3/16" figures, white on black. Ideal for all high-speed electric counting applications — accurate at high, low or intermediate speeds.

DURANT MANUFACTURING CO.
1914 N. Buffum St., 14 Thurbers Ave.
Milwaukee 1, Wis. Providence 5, R.I.
Representatives in Principal Cities

ALASKA GRAY
AND SEAL BROWN





Compact, with great rigidity — entirely enclosed against dust and moisture. Base or panel mount. Speeds to 1500 C.P.M.

PRODUCTIMETERS SINCE 1879 *Count Everything*

For more information circle **106** on inquiry card.

USE **dekatron**®

COUNTING TUBES FOR RELIABLE, HIGH SPEED COUNTING APPLICATIONS

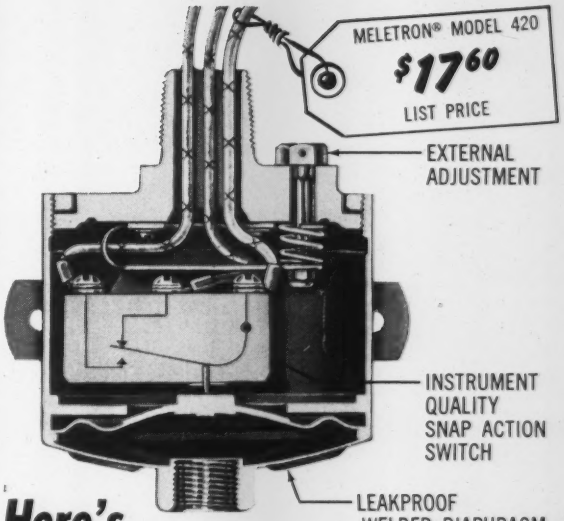
Baird-Atomic uses DEKATRON glow transfer tubes in all instruments where counting and read-out are required. A typical application is the Atomic Instrument Line's Model 134 Scaler for ultra-high speed counting of beta and gamma radioactivity . . . up to 1,000,000 counts/minute! The input circuit incorporates a fast, constant-sensitivity Schmitt discriminator driving a beam switching decade with glow tube read-out . . . 6 DEKATRONS.

You too, can count on DEKATRON for reliable performance. For detailed information request Data Sheet IC 4001.

Baird-Atomic, Inc.
33 UNIVERSITY RD., CAMBRIDGE 38, MASS

Instrumentation for Better Analysis

For more information circle **107** on inquiry card.



Here's the Simplest Diaphragm Pressure Switch

WE BUILD IN	WE DON'T USE
EXTREME ACCURACY and DEPENDABILITY maintained during operating life due to direct acting design	LINKAGES & BEARINGS which, as they wear, make the setting of the pressure switch drift.
OPERATION IN ANY POSITION which saves the installation costs encountered in mounting a switch that uses liquid switching elements	LIQUID SWITCHING ELEMENTS which make the switch difficult to mount and very critical to vibration.
IMMUNITY TO VIBRATION you can mount the switch directly on your vibrating or moving equipment.	ACCORDION BELLOWS which make the pressure switch sensitive to vibration.

ASK FOR NEW CATALOG 9-PS FREE

PRESSURE SWITCH DIVISION

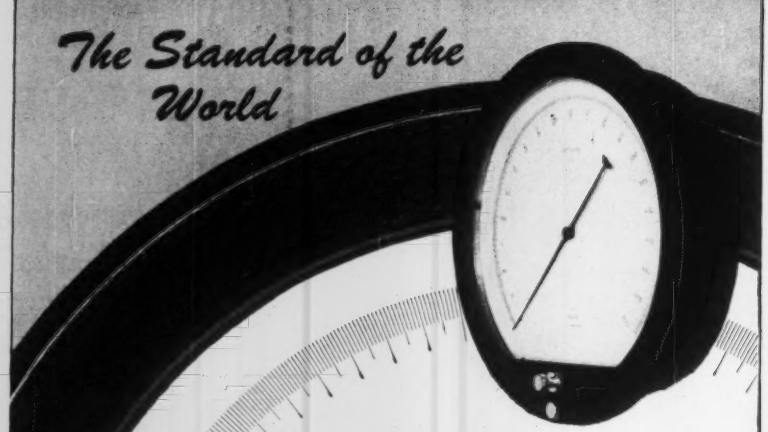
barksdale valves

5125 Alcoa Avenue, Los Angeles 58, California

For more information circle **108** on inquiry card.

HEISE GAUGES

The Standard of the World

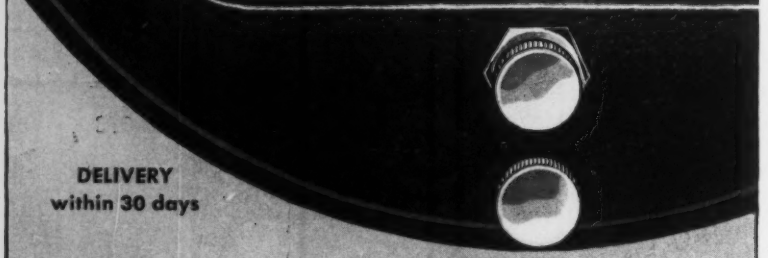


Heise Laboratories specialize in the manufacture of precision laboratory instruments for critical fluid pressure applications.

The Heise Gauge is a world recognized standard for pressure measurement used by many laboratories in place of the dead weight tester for reference data.

Heise Engineers are always available for advanced research and development. Prompt and skillful attention to inquiries in the precision pressure instrument field is a Heise tradition.

PRESSURE RANGES	DIAL SIZES	PRICES
15 to 50,000 P.S.I.	8½"-12"-16"	from $166.75



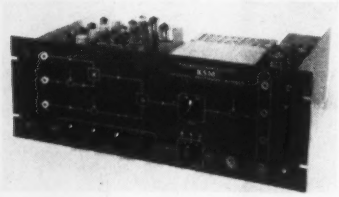
DELIVERY within 30 days

HEISE BOURDON TUBE COMPANY, INC.
BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

For more information circle **109** on inquiry card.

MULTIPLIER-DIVIDER

New Model K5-M Multiplier-Divider is a precision analog-computing component based on an all-electronic semiconductor network. It accepts three variable inputs e_1, e_2, e_3, and



provides as output e_1e_2/e_3. The standard range of inputs and outputs is plus and minus 50 v. No external equipment is necessary to obtain products, ratios, squares, square roots or absolute values. Accuracy as a multiplier, including drift, is better than 1/10 v in all four quadrants.—*George A. Philbrick Researches, Inc., 285 Columbus Ave., Boston 16, Mass.*

For more information circle **223** on inquiry card.

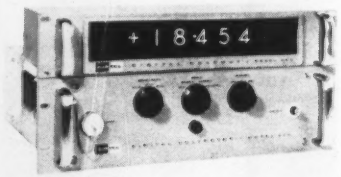
INTEGRATED CONTROL SYSTEM

New Integrated Control Systems, pre-engineered, pre-assembled and pre-tested, to eliminate on-the-job assembly of control components, allow simple connection of power and control circuits.—*Photoswitch Div., Electronics Corp. of America, One Memorial Dr., Cambridge, Mass.*

For more information circle **224** on inquiry card.

DIGITAL VOLTMETER

New Model 501 Digital Voltmeter uses a fifth digit to ensure accuracy at the upper limit of each range. Most 4-digit instruments have an abrupt



loss of sensitivity when the reading reaches 9999 in any lower range. The new meter adds a first-place "one" when the upper range limit has been reached. Thus, the 0-9.999 range becomes 0-19.999, with millivolt accuracy retained well into the 0-99.99 range. A built-in printer drive is capable of driving 10-line parallel-input printers, without accessories. Accuracy is 0.01% ± one digit.—2-page Data Sheet 19-27 contains details.—*Kin Tel a Div. of Cohu Electronics, Inc., 5725 Kearney Villa Rd., Box 623, San Diego 12, Calif.*

For more information circle **225** on inquiry card.

new SCHERR
TOOLMAKERS MICROSCOPE

WITH INTERCHANGEABLE DIAL TEMPLETS AND OCULARS

57
58
59
Reading Angles in Minutes
Thread Templets for U. S. National Thread Profiles-6-80 Pitch. Radil Templets, etc.
LARGE MICROMETER DRUMS READ DIRECTLY IN .0001"
Measuring Range 2" x 1-1/2" and other sizes
A moderately priced PRECISION MEASURING TOOL for Toolroom and Inspection

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For more information circle 110 on inquiry card.

PROCESS CONTROL ANALYSIS

by Millard H. LaJoy and E. Allen Baillif . . . an essential first step in analysis of closed-loop controlled process via frequency response of the system. 1956. Cloth, 72 pages, illustrated **$2.00**

AUTOMATIC CONTROL TECHNOLOGY, MODERN THEORY AND THEIR USEFULNESS

edited by Gerd Mueller, for VDI/VDE-Fachgruppe Regelungstechnik. Includes 90 advanced papers on control technology, as delivered in original language (English, French, Russian; all Russian papers are translated into German; about ½ of the book is in English). 9″ x 12″. Handsome cloth binding. Printed by R. Oldenburg Verlag, Munich, Germany. 433 + XV pages. 1957. 898 illustrations and 48 tables **$25.00**

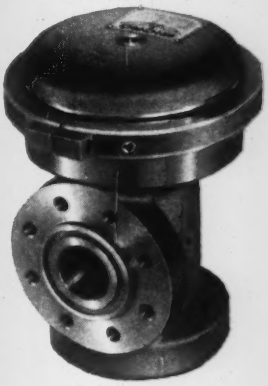
THE AUTOMATIC FACTORY

by June, Bardis, Lurio, Polaner, Sagedahl, Sklenar and Yenken. Here is THE book for all who want FACTS rather than wild opinions . . . a fresh viewpoint on what "manless factories" CAN be—a book free from the generalities, platitudes, exaggerations, and misconceptions repeated by many writers on this subject. 1955. Cloth, 88 pages, illustrated **$1.50**

INSTRUMENTS PUBLISHING COMPANY
845 Ridge Avenue, Pittsburgh 12, Penna.

MICRO DELTA p CONTROLLER

provides back pressure control in LESS THAN A SECOND!


SERIES 4000

When overshooting the control point is objectionable or intolerable, IEC's Micro Delta p Controller will restore accurate, stable back pressure control—*within a fraction of a second!*

This compact "packaged" system—pressure sensing element and control valve—requires only *one-fourth* the space of a conventional air controller and diaphragm valve. Cost, in many cases, is less than that of a control valve alone.

The Micro Delta p's speed of response—*without hunting*—makes possible the use of multiple control points with minimum transient time. It also features square-wave pressure response and constant pressure throughout full pressure range.

Available now in five types for a wide range of pressure and flow conditions. Write for Bulletin 544 for complete details and prices.

INDUSTRIAL IEC ENGINEERING CORP.

INDUSTRIAL ENGINEERING CORPORATION
529 E. Woodbine, Louisville 8, Kentucky
Designers, engineers, and manufacturers of hydraulic and electronic test equipment, consoles, panels, etc.

For more information circle 112 on inquiry card.

NOW...ACCURATE TEMPERATURE DATA with Thermophil THERMISTOR THERMOMETER

- **ACCURACY:**

	70°C/range	20°C/range
− 50° to 50°C	±0.7°C	±.15°C
+ 50° to 100°C	±1.0°C	±.2°C
+100° to 200°C	±1.5°C	±.3°C
Readability	.25°	.1°

- **FASTEST RESPONSE:** time constant: .75 seconds in liquids; 2.2 seconds on surfaces.
- **ONE HUNDRED INTERCHANGEABLE PROBES, TWENTY-SIX INSTRUMENTS** Readings between −328°F to 845°F or C equivalent.
- **BATTERY POWERED,** as pictured, or AC models (portable or panel mountable).
- **STABLE EUROPEAN THERMISTOR** resistance element, bridge circuit and amplifier.

USED BY G.E., duPont, Westinghouse, etc.

INTRODUCTORY OFFER
COMPLETE $180.00

Instrument as pictured, °F or °C.
Temperature range, overlapping:

	Model #4412F	Model #4412C
Scale I	32° to 158°F	0° to 70°C
Scale II	158° to 284°F	70° to 140°C
Scale III	284° to 410°F	140° to 210°C

with one probe, choice of . . .
#H10AO stainless steel for surfaces
#H01AF glass tipped for liquids
#H12AF stainless steel needle

ATKINS TECHNICAL, INC.
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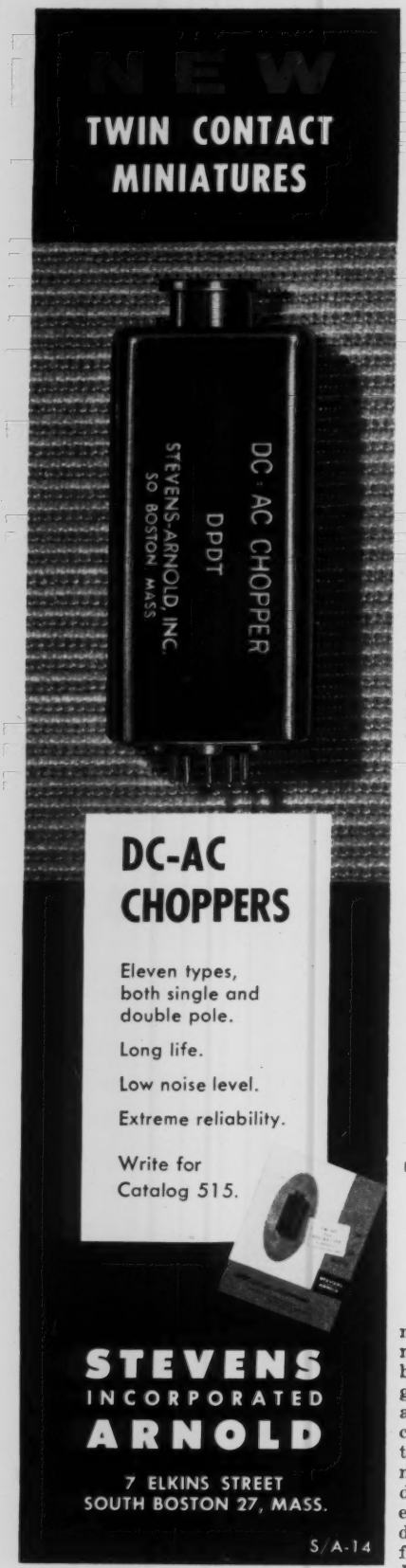
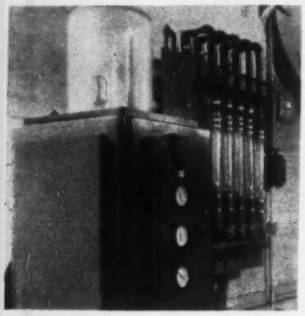
For more information circle 113 on inquiry card.



See us at the I.R.E. Show—Booth 2934

For more information circle **114** on inquiry card.

LABORATORY ROTAMETERS

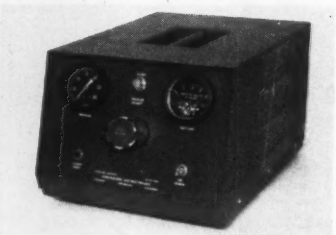


New line of Laboratory Rotameters with flexible connections has accuracy within 2% of maximum rate of flow, over a wide range of fluid viscosities and densities. Over 50 flow ranges are available from a few cu cm/min to 90 gpm. Illustration shows five SK Laboratory Rotameters mounted by Wallace & Tiernan on a chlorine solution distribution panel for proportioning flow to several points of application.—*Schutte and Koerting Co., Cornwells Heights, Bucks Co., Penna.*

For more information circle **226** on inquiry card.

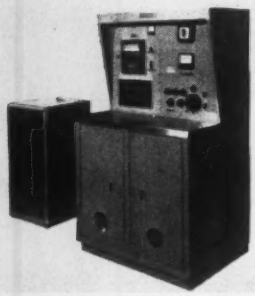
MOISTURE MONITORS

New Type 26-350 series high-pressure Moisture Monitors provide rapid and accurate measurement of trace quantities of moisture in gases, gaseous mixtures, and vapors at sample pressures up to 10,000 psig. Based on an electrolytic process developed by E. I. du Pont de Nemours & Co., the moisture monitors cover a dynamic range of one ppm to 1,000 ppm.—*Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif.*



For more information circle **227** on inquiry card.

THERMOCOUPLE CALIBRATOR

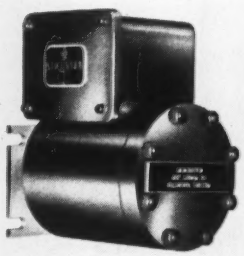


For more information circle **228** on inquiry card.

New Model TC-2 Thermocouple Calibrator provides accurate calibration of thermocouples used for controlling and recording test temperatures. Unit consists of potentiometer, standard cell, null indicator, wet-cell storage battery for the potentiometer, 24-point rotary switch, NBS-calibrated platinum/platinum-rhodium thermocouple, and furnace control instrumentation. The calibrator also has an F-4 modified furnace with a 4-¾" I.D. Kanthal-wound double-core of five-zone construction.—*Arcweld Mfg. Co., Grove City, Penna.*

PRESSURE TRANSDUCERS

New Pressure Transducers for primary and secondary loop measurements in pressurized-water reactors, boiling-water reactors, and some organic-moderated and homogenous reactors, are built entirely of inorganic components, thus suitable for operation in heavily radioactive environments without being affected. Transducers basically consist of a pressure element (helical or capsular), and a differential transformer. Ranges are from 0-1" WC to 0-10,000 psig.—*The Bristol Co., Waterbury 20, Conn.*



For more information circle **229** on inquiry card.

INSTRUMENT
DAVIS
DIVISION

GAS ANALYSIS INSTRUMENTS

Continuous and Portable units

✓ **CHROMATOGRAPHIC ANALYZERS**

Complete systems for laboratory and process stream analysis — control.
CHROMA-CAT series extends utility of analysis, allows use of AIR as carrier gas.

✓ **ELECTRO-CONDUCTIVITY ANALYSIS**

Continuous measuring for PART PER MILLION toxic gases in work areas; impurity control in process streams. Applicable on any gases (or gas combustion products) which ionize in water.

✓ **COMBUSTIBLE GAS ANALYZERS**

REMOTE HEAD and multi-point systems for detection of combustible gases and vapors in work areas; Litho and coating oven atmosphere control; etc. Control of combustibles in inert gas streams.

✓ **THERMAL CONDUCTIVITY ANALYZERS**

MEASUREMENT of concentration of one gas component in a mixture of gases utilizing sensitive T/C filaments as the detector. Applicable for determination of: H_2 in $O_2 \cdot N_2$ mixtures; Argon in Air; Hydrogen purity; CO_2 in flue gas, etc.

Write for Descriptive Literature

DAVIS INSTRUMENTS
A Division of Davis Emergency Equipment Co., Inc.

80 Halleck St., Newark 4, N. J.

For more information circle **115** on inquiry card.

MAGNETIC SHIELDS

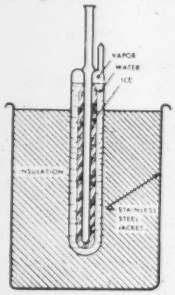
New Magnetic Shields for cathode-ray tubes, available in Netic or Co-Netic materials or in multiple layers

of both materials, have original low retentivity and other magnetic properties despite new design and fabrication methods used, which enabled price reduction.—*Magnetic Shield Div. Perfection Mica Co., 1322 N. Elston Ave., Chicago 22, Ill.*

For more information circle **230** on inquiry card.

TEMPERATURE STANDARD

New Equiphase Cell, a Primary Temperature Standard using newly-defined triple point of water (0.01°C),

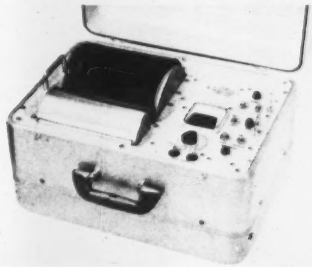


by partially freezing pure water in an evacuated and sealed glass system, maintains its true reference temperature of 0.01°C when ice, water and water vapor exist at 4.58 mm Hg.—*Trans-Sonics, Inc., Burlington, Mass.*

For more information circle **231** on inquiry card.

MAGNETIC RECORDING

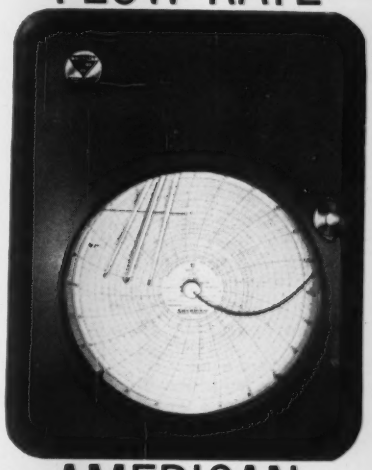
New portable TI-551 transistorized Magnetic Recording and Playback System provides 24 data channels, one



timing channel, and two auxiliary channels, primarily for use in seismic exploration. All recording and playback assemblies, 12-v power supply, and controls are contained in an aluminum case for hand-carrying or for mounting in a recording truck. Recording medium is a standard Techno TI-410 or TI-510 six-second recording sheet.—*Techno Instrument Co., 6666 Lexington Ave., Los Angeles 38, Calif.*

For more information circle **232** on inquiry card.

PRECISION MEASUREMENT AT ANY FLOW RATE



AMERICAN-WESTCOTT

A-88

ORIFICE METERS

Versatile American® Series A-88 mercury-type orifice meters meet the toughest flow measurement requirements – working pressures to 5,000 psi – interchangeable 10, 20, 50, 100 and 200-inch ranges. Recording meters may be equipped with 0-150° F. standard temperature element. Integrating meters integrate static and differential pressure, providing totalized flow indications. Telemetering equipped meters transmit integrated indications to remote locations.

- Manometer body easily cleaned – does not affect calibration.
- Tamper-proof calibration – simple, positive adjustment of float lever arm length.
- Interchangeable ranges – no manifold piping changes.
- Teflon-packed stuffing box is pressure tight, nearly frictionless, never needs lubrication.
- Teflon-packed pulsation dampener externally adjustable under full line pressure.
- Check valves give positive shut-off for over-range protection.

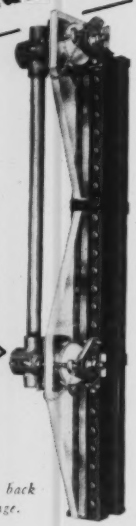
AMERICAN® METER COMPANY
INCORPORATED (ESTABLISHED 1836)

General Offices: Philadelphia 16, Pa.
Sales offices in principal cities

For more information circle **116** on inquiry card.

New Improved JERGUSON Gage Illuminator

gives up to 3 times the illumination



Low cost explosion-proof lighting of entire gage glass with no glare or blind spots

New Features:

Simplified Relamping . . . loosen one thumb screw to lift out cover and glass housing in one piece.

New Safety Chain prevents accidental dropping.

Now both UL and CSA Approved.

Easily mounted on back of Transparent Gage.

The New Jerguson EPL-56 Illuminator gives three times the illumination (and 3 times the bulb life) . . . a bright, evenly diffused light over the entire length of gage glass, thus enabling you to see the liquid level clearly and easily under all conditions. Relamping is simplified: one turn of the thumb screw and you lift out cover and glass housing in one piece.

Jerguson Illuminators incorporate the principle of solid wedge lighting. Illumination from a single bulb is reflected from the angular surface of the plastic wedge and is evenly diffused through the transparent gage glass.

Jerguson Illuminators are UL approved and are built in accordance with their Standard for Electric Lighting Fixtures for use in hazardous locations for Class 1, Group D Services. They are made in a variety of sizes.

Write for Data Unit on Process Gage Illuminators.

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY

100 Adams Street, Burlington, Mass.

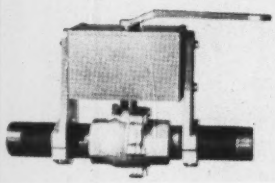
Offices in Major Cities

Jerguson Tress Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

For more information circle **117** on inquiry card.

SERVO VALVE-ACTUATOR

New electric Valve Actuator, a servo type mechanism for automatic operation of ball valves and other

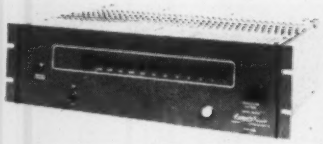


rotary-stem type valves, requires no air lines or air compressors. Available for ¼" to 8" valves, each model delivers many times the torque required to operate the valve for which it is rated.—*R & A Machine Co., Inc.*, 100 *Grove St., Worcester* 5, *Mass.*

For more information circle **233** on inquiry card.

V/D-D/V CONVERTER

New Model TB-713 Transicon is a modularized, transistorized, completely reversible voltage-to-digital, digital-to-voltage high-speed Converter. The output code is 13-bit straight binary

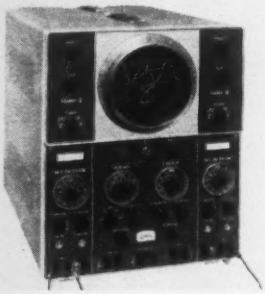


including sign information. The voltage-to-digital conversion accuracy is ±0.5% or 1 mv (whichever is greater), ± ½ the least significant bit. The digital-to-voltage conversion accuracy is ±0.05% or ±1 mv. Unit features up to 25,000 conversions/sec analog-to-digital; and up to 100,000 conversions/sec digital-to-analog.—*Epsco, Inc., Instrument and Equipment Div.*, 588 *Commonwealth Ave., Boston* 15, *Mass.*

For more information circle **234** on inquiry card.

DUAL-BEAM 'SCOPE

New Type 411 Dual-Beam Oscilloscope is capable of displaying x-y plots while simultaneously displaying either the x- or y-signal against time, by using a multi-gun cathode-ray

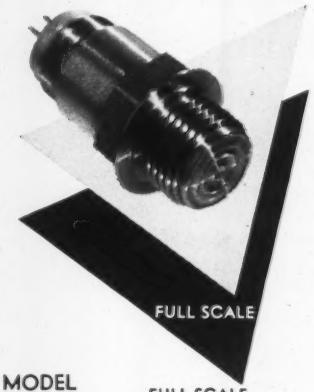


tube. A unique switching arrangement on the front panel develops nine major modes of display. By introducing Z-axis modulation, 27 additional useful display modes are possible. Vertical resolution is 20 uv. Transis-

Dynisco

Thermally Insulated

PRESSURE TRANSDUCER



MODEL PT 61 — FULL SCALE

Incorporates Unbonded Strain Gauge

HIGHLIGHTS

► WELDED FLUSH-MOUNTED DOUBLE DIAPHRAGM

► MAXIMUM OUTPUT TRANSIENT DUE TO SUDDEN DIAPHRAGM TEMPERATURE CHANGE OF 100°F IS LESS THAN 2% OF FULL OUTPUT

► NON-LINEARITY LESS THAN ½%

► MINIATURE SIZE

PRESSURE RANGES
0-250 to 0-1500 psi

REQUEST BULLETIN NO. 5803

For more information on Dynisco pressure, force, flow, and displacement pickups,

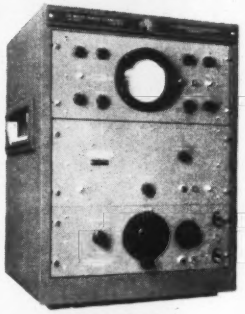
write:

DYNAMIC INSTRUMENT CO.

42 Carleton Street
Cambridge 42, Mass.
UN 4-7260

For more information circle **118** on inquiry card.

TYPE 7000-B AUDIO PRIMARY PHASE STANDARD



FEATURES:

- ±0.05° Phase Shift Accuracy
- 30 cps to 20 kc Frequency Coverage
- 0° to 360° Continuous Phase Shift
- Ultimate Accuracy of ±0.01°
- Self-Calibrating
- Long-Term Operating Reliability
- Lissajous Pattern Presentation

The Type 7000-B Audio Primary Phase Standard supplies two sinusoidal voltage signals whose phase relationship is known to ±0.50° and is continuously variable from 0° to 360°. The frequency of the two signals is the same and is set at one selected frequency from 30 cps to 20 kc.

Specifications

Frequencies: Any single frequency from 30 cps to 20 kc. Frequency is set with an accuracy of ±0.05%.

Accuracy of Phase Angle: ±0.05°. For angles which are multiples of 1°, carefully taken readings are accurate to 0.01°.

Output Voltage Range: 1 to 12 volts (rms).

Output Distortion: Total harmonic distortion less than 0.05%, provided output voltage is within specified range of 1 to 10 volts (rms).

Output Impedance: Approximately 200 ohms (from cathode follower).

Power Supply: 105-125 volts, 50-60 cycle electronic-regulated, self-contained supply, requiring approximately 450 watts.

Physical Specifications

Dimensions: 21¼" wide x 31" high x 21½" deep.

For full details and specifications, wire or call

ACTON LABORATORIES, INC.

531 Main Street, Acton 9, Mass.
COlonial 3-7756

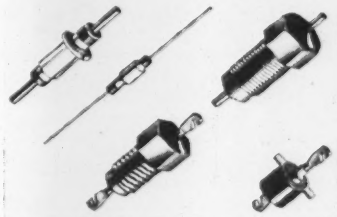
For more information circle **119** on inquiry card.

torized regulation of filament power supplies assures maximum stability, compensating for wide variations in power-line voltages and ambient temperatures. Frequency response extends from dc to beyond 100 kc and the instrument features a full-scale amplitude-measuring range of from one mv to 500 v in 17 steps.—*Allen B. Du Mont Labs., Inc., 750 Broomfield Ave., Clifton, N. J.*

For more information circle **235** on inquiry card.

FEED-THRU FILTERS

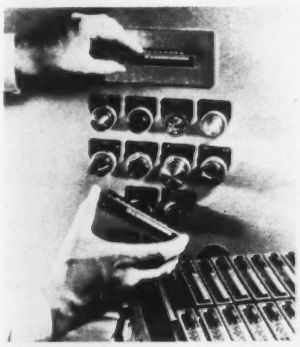
New line of filter elements for the elimination of high-frequency radiation and feed-back in low power circuits in the frequency range from 50 mcps to 5000 mcps (which covers the P, L, and S military bands), features much greater effective capacitance at VHF, UHF, and higher frequencies than is indicated by the nominal capacitance as measured at 1 kcps.—*Allen-Bradley Co., 136 West Greenfield Ave., Milwaukee 4, Wis.*



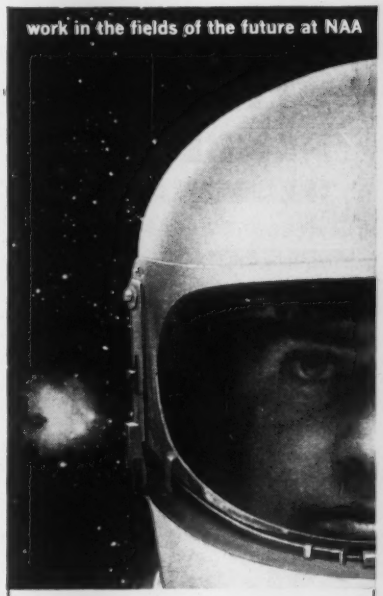
For more information circle **236** on inquiry card.

AUTOMATIC BATCHING

New Batchplug Automatic Batching System provides instant formula changing with complete preset weigh control for up to ten ingredients by screwdriver adjustment behind exchangeable formula panel. Individual Batchplugs can be accurately sealed within one scale graduation. Five basic Batchplug models are available to control up to ten ingredients with up to three scales.—Four-page Bulletin EP-SD-29 contains details.—*Howe Scale Co., Rutland, Vt.*



For more information circle **237** on inquiry card.



TRAINING EQUIPMENT DESIGN

The Los Angeles Division of North American Aviation—Weapon System Manager for the nation's two most advanced manned weapon systems, the B-70 and F-108—has top-level positions available for

Training Simulator Designers

These highly-qualified engineers will coordinate and monitor the over-all design of training simulator equipment for the most advanced weapon systems projects.

Background preferred: Graduate Electrical Engineer with minimum of four years' experience in design of analog and digital computers with application to simulation requirements.

For more information please write to: Mr. A. P. Stevenson, Engineering Personnel, North American Aviation, Inc., Los Angeles 45, California.

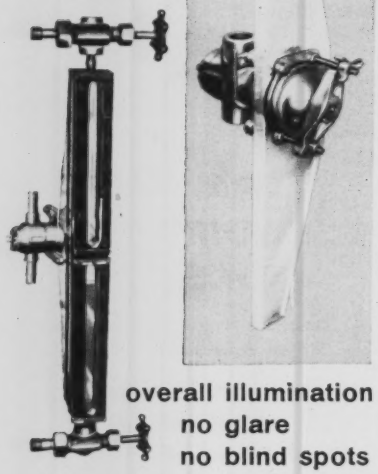
THE LOS ANGELES DIVISION OF

NORTH AMERICAN AVIATION, INC.

NEW!
PENBERTHY ILLUMINATORS
for Liquid Level Gages

58 WATT 3000 HOUR BULB

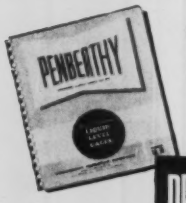
accurate readings



overall illumination
no glare
no blind spots

Faster, more accurate liquid level readings are provided by Penberthy's new, improved, explosion-proof, dust-tight illuminators. 58 Watt Bulb (with medium screw base) gives higher light intensity for 4-times the life of ordinary illuminators. Exclusive rugged aluminum housing over bulb extends bulb life, offers better protection and simplifies relamping. Clear plastic wedge diffuses light over entire length of gage glass.

Illuminators are easily installed on present or new gages. Available in single or double sections, they are used in combination for gages with 3 or more sections. Approved by Underwriters' Laboratories for Class 1, Group C and D hazardous locations.



For further information on Penberthy Illuminators, liquid level gages and valves, write or phone. Ask for Catalog #36.

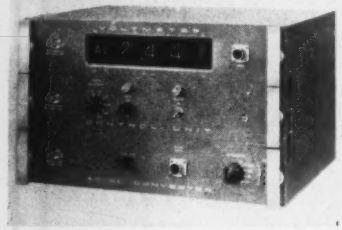
PENBERTHY

PENBERTHY MANUFACTURING CO.
Division of Buffalo-Eclipse Corporation
1242 Holden Ave., Detroit 2, Michigan

For more information circle **120** on inquiry card.

AC/DC CONVERTER

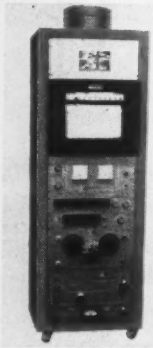
New AC/DC Converter for use with the Cubic Digital Voltmeter and Control Unit offers high negative feedback over the stated frequency range, 30-20,000 cps, assuring a linearity of 0.01% and a stability of 0.02%. The negative feedback provides inherent gain stability. Full-wave rectification provides an accuracy of ± 0.1% and 2 digits on 4 ranges. Use of vacuum tubes is the design feature responsible for high output voltage capability, high input impedance, and high gain stability.—Bulletin 102-D gives details.—*Cubic Corp., 5575 Kearny Villa Rd., San Diego 11, Calif.*



For more information circle **238** on inquiry card.

SCINTILLATION SPECTROMETER

New automatic recording gamma Scintillation Spectrometer includes a pulse-height analyzer with 3-speed reversible motor drive, a Model 412 Dual Rate Meter and a dual recorder. It produces simultaneous linear and logarithmic plots.—*Baird-Atomic, Inc., 33 University Rd., Cambridge 38, Mass.*



For more information circle **239** on inquiry card.

DC/AC POWER SUPPLIES

New line of RC-Nobatron Rangers variable-output unregulated Power Supplies providing both d-c and a-c

MULTI-MINIATURE
FEATURES
with
PACKLESS "DEMI G" VALVES

Photo 3/4 actual size

"DEMI G" SERIES

Packless "DEMI G" Valves are miniature in size, weight and price. They employ a patented form and give bubble-tight shut-off. They are available in many bar-stock materials with a wide variety of tee-handle and toggle actuators and have innumerable applications in the chemical, oil, instrumentation, aircraft and atomic energy fields . . . to name but a few.

Basic "DEMI G" Valves employ metal-to-metal seating, however TEFLON seats for vacuum service, neoprene diaphragms for toggle actuation and all TEFLON interior models . . . as well as those with bolted bonnets are standardly available. Where space and exacting control are considerations, the "DEMI G" Series of packless valves will do the job better.

PRESSURE RATING Metal Body & Diaphragm Neoprene Diaphragm TEFLON Body & Diaphragm	 750 psi at 450°F 100 psi at 180°F 100 psi at 450°F
MAXIMUM Cv	0.4
CONNECTIONS	1/16" to ½" N.P.T.

Send for the "DEMI" Catalog D-1 and other technical data on Dahl pneumatic and hydraulic valves.

GEORGE W.
DAHL
COMPANY, INC.

86 TUPELO STREET, BRISTOL, RHODE ISLAND

For more information circle **121** on inquiry card.

outputs for general purpose laboratory or production-line test-bench applications consist essentially of a variable autotransformer, rectifier and filter circuit. D-c models are available from zero to 36 and zero to 150 v, each having available zero to 130 v a-c.—Product Data Sheet DC270 contains details.—*Sorensen & Co., Inc., Beta Div., Richards Ave., South Norwalk, Conn.*

For more information circle **240** on inquiry card.

DATA REDUCTION SYSTEMS

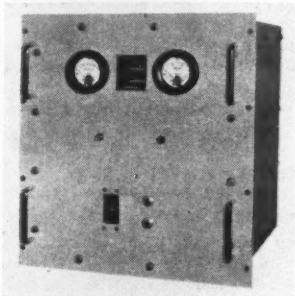
New Pulse Code Data Gathering and Reduction System, Fig. 9346 Series, handles liquid level, temperature, pressure, positive-displacement-meter readings, and other variables. It can

be used also for logging the status of various operating equipment such as valves, pump motors, etc. The smallest-capacity unit will handle 48 points and, for larger capacities, the number of points is usually increased in multiples of 48. The complete system can be operated from a small control console designed for desk-top or shelf location.—Bulletin No. CP-3704 gives details.—*Vapor Recovery Systems Co., 2820 North Alameda, Compton, Calif.*

For more information circle **241** on inquiry card.

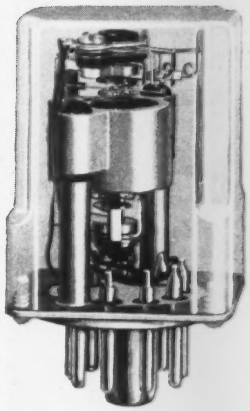
D-C POWER SUPPLY

New completely transistorized d-c Power Supply, Model M-1136A provides 24-32 v at 100 amps from an a-c input of 208 v ±10%, 3 phase, 57-63 cps with static and dynamic



regulation accuracy of ±0.1% between 187 and 229 v. The unit is constructed using specification MIL-P-6457 and MIL-G-008512A as a guide. —*Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.*

For more information circle **242** on inquiry card.



DECISION MAKER

for simplified monitoring, controlling, high-precision switching

Normal/abnormal . . . high/low . . . go/no-go: these are important decisions being made by A.P.I. Very High Sensitivity Measuring Relays.

Direct from sensory elements or circuits, the A.P.I. measuring relay makes a decisive "yes or no" decision on the basis of very close-tolerance voltage or current changes. In typical, critical applications, this measuring relay is saying "yes or no" on a change of ±1 microamp; or in a 400- to 500-volt circuit, on a variation of only a few percent.

Moreover, the relay is capable of actuating on very tiny currents: for example, total inputs as small as 0.2 microampere or 0.1 DC millivolt. It does so without signal amplification, amplifier costs or the signal distortion problems that often go along.

Performance stability is inherent; reliability is exceptional due to the A.P.I. locking-coil design. On "make", contact is firm with substantial contact pressure; contact resistance is low. On "break", separation is clean and quick without contact teasing.

10,000,000 perfect operations is not an all-time record; it's a reasonable expectation of service life.

Widely used for precision switching in computer, control and alarm circuits, VHS measuring relays are practically unlimited in scope of application.

For more information, send for Bulletin 104-D.

api **ASSEMBLY PRODUCTS, INC.**
Chesterland 10, Ohio

S-A. 1903-C

For more information circle **122** on inquiry card.

POST DECITRON ELECTRONIC PRODUCTS

Now . . . low cost . . . accurate "batch" counting for small products.

The *PORTABLE* FCB-1

The Post FCB-1 is a sorting and counting device which incorporates a Syntron vibrator with a Decitron Preset Counter. Model illustrated utilizes a P2 counter, capable of 'batch' counting small objects in any quantity from 1 to 100.

Very small products can be neatly separated on the special conveyor belt . . . individually counted . . . dropped into a 'hold' tray and when the desired count is reached, the entire batch is fed into a waiting box, bag or other container. This latest Post development will feed 300 to 1000 pieces per minute and is **portable!** Size: only 53" long, 18" high, 12" wide. Cost as shown, $3500.

Post will be glad to furnish quotations for models capable of counting larger batches.

Decitron

POST ELECTRONICS

Division of Post Machinery Co. | 165 Elliott St., Beverly, Mass.

For more information circle **123** on inquiry card.

TURNTABLE DEGAUSSER

semi-automatic — total erasure

for all instrumentation tapes and magnetic films

The MAGNASYNC Model A-937 DEGAUSSER features a predetermined 20-second timed cycle that completely eliminates guesswork. The pushbutton-controlled motor-driven turntable insures fast and complete bulk erasure and eliminates noise patterns which are generated by irregular rotational motion. **$159.50**

Model M-937 MANUAL DEGAUSSER — smooth, free-wheeling turntable, will not damage edges of instrumentation tapes or films. **$119.50**

Model G-936 CONVENTIONAL DEGAUSSER — an effective bulk eraser economically priced. **$69.50**

immediate delivery

MAGNASYNC Manufacturing Co., Ltd.

5542 Satsuma Ave., North Hollywood, California

For more information circle **124** on inquiry card.

Flow Visualization Instrumentation

Schlieren Systems
Shadowgraphs
Interferometers
Wind Tunnel Optics
Mountings & Piers
Packaged Systems

Catalog upon request

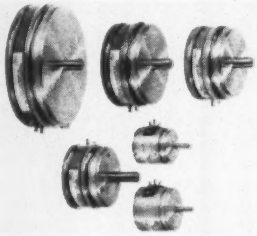
John Unertl Optical Co.

3551-3555 East Street
Pittsburgh 14, Penna.

For more information circle **125** on inquiry card.

SERVO POTENTIOMETERS

New series of High Precision Servo-Potentiometers features low-torque, linear or non-linear windings, and multiple taps. Available with diameters of ⅞," 1⅛," 1⅜," 1¾," 2" and 3" and ganged to re-

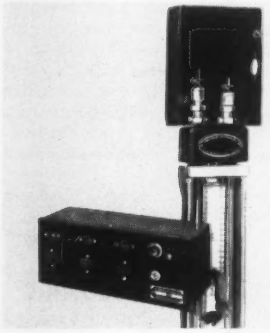


quirement, standard units employ all precision-machined parts and precision ball bearings resulting in high mechanical accuracy.—*Circuit Instruments Inc.*, 2801 *Anvil St., North, P. O. Box* 11628, *St. Petersburg* 33, *Fla.*

For more information circle **243** on inquiry card.

PRESSURE SWITCH

New precision Pressure Switch consisting of a contactor manometer and a relay-power-supply package (trade-named Manotac) can be used for alarm signalling and/or control in applications involving pressure, vacu-

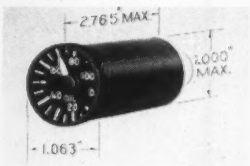


um, differential pressure, flow and liquid level. The use of a special indicating fluid (sp. gr.= 1) gives a make-or-break control sensitivity of 0.005" WC; the instrument can sense pressure increments as small as 0.003 oz/sq in.—*Meriam Instrument Co.*, 10834 *Madison Ave., Cleveland* 2, *Ohio*

For more information circle **244** on inquiry card.

MINIATURE INDICATOR

New 1" Miniature Indicator, Type IND-9811-02 meets MIL-I-25950 and is integrally lighted to MIL-L-25467A.



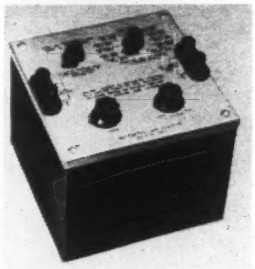
Filled with inert gas and hermetically sealed, it also meets environmental

requirements of MIL-E-5272A and applicable portions of MIL-I-7057. Rotor input is 26v, 400 cycles, stator output 11.8v, 400 cycles and input to lamps 5v, 400 cycles. Designed for remotely indicating jet engine oil pressure but can be adapted to any type of indicator function.—*John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wis.*

For more information circle **245** on inquiry card.

WATTMETER-VAR ADAPTER

New Model 100, Wattmeter-Var Adapter for 60-cycle measurements can be used with all dynamometer wattmeters, thus increasing their value by allowing them to perform



the functions of Var-meters and power-factor meters in addition to measuring watts, without requiring circuit alterations.—4-page bulletin contains details.—*Vars Company, P. O. Box 272, Park Ridge, Ill.*

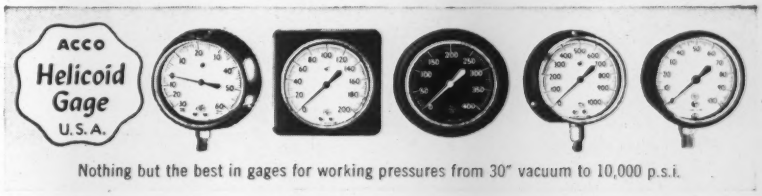
For more information circle **246** on inquiry card.

CONTINUOUS TRACE SAMPLING

New sampling system for trace contaminants in industrial chemical process streams has three major elements assembled in one cabinet. Illustration shows air sampler, infrared analyzer, and recorder for tracing

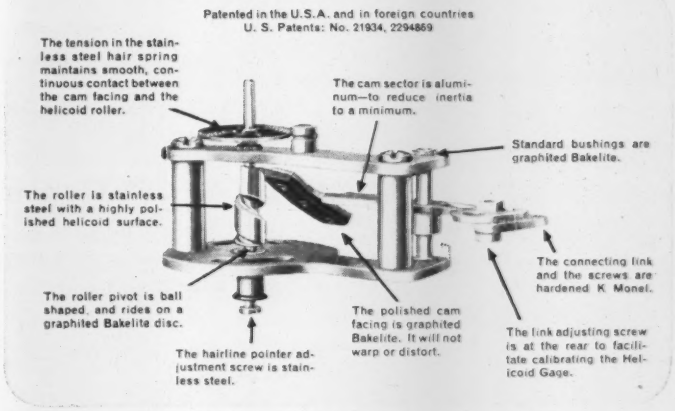
hydrocarbons in air entering an air separation plant. Other systems can trace acetylene in liquid oxygen, or unburned hydrocarbons in exhaust gases, or acetylene in ethylene, or measure dewpoints at low temperatures (−100°F to −30°F), etc., with variations in the major constituents of the systems.—*Mine Safety Appliances Co., 201 N. Braddock St., Pittsburgh 8, Pa.*

For more information circle **247** on inquiry card.



Nothing but the best in gages for working pressures from 30" vacuum to 10,000 p.s.i.

These details of Helicoid gage design assure longer life and enduring accuracy


Patented in the U.S.A. and in foreign countries
U. S. Patents: No. 21934, 2294859
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is aluminum—to reduce inertia to a minimum.
Standard bushings are graphited Bakelite.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

The superiority of Helicoid Gages is most evident in severe service—wherever a gage is subjected to violent pressure pulsations or severe mechanical vibrations.

The *sustained accuracy* of Helicoid Gages over *millions of cycles* is explained by the details of design and construction of the Helicoid movement shown above. Such Helicoid features—protect against wear and corrosion and assure sensitivity, sustained accuracy and trouble-free operation.

The Chemical Gage

The Helicoid Chemical Gage has a guaranteed accuracy of plus or minus 1%. It is applicable for working pressures from 30" vacuum to 5000 p.s.i. and temperatures to 400° F. It is particularly suitable for chemicals and other viscous fluids which might clog or corrode a Bourdon tube. Pressure and/or vacuum is transmitted directly to the indicating gage element through deflection of a Teflon or Kel F sealing diaphragm.

Tubes built for millions of pressure pulsations

To fit the wide range of applications, Helicoid Bourdon tubes are available in four materials—alloy steel, K Monel, stainless steel and phosphor bronze.

All Helicoid tubes are made from seamless tubing and are carefully designed to give maximum torque and minimum stress. When used within the dial range, they will withstand many millions of pressure pulsations and will not stretch, leak or crack.

For complete information on the Helicoid line of gages write for **Catalog G-52**

Helicoid gives you all these features at prices that are competitive in the quality gage field.

Helicoid Gage Division
AMERICAN CHAIN & CABLE

929-B Connecticut Avenue • Bridgeport 2, Connecticut

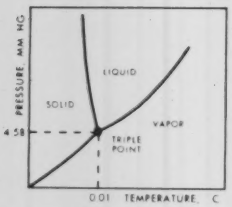
ACCO
TRADE MARK

For more information circle **126** on inquiry card.

Scientific Announcement

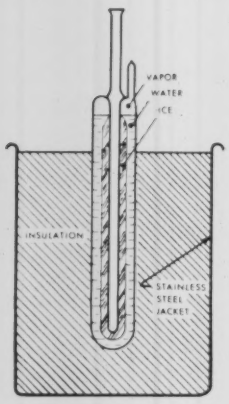
NEW PRIMARY STANDARD FOR TEMPERATURE

A new primary temperature standard, using the triple point of water, is now in use in national standards laboratories throughout the world. This new standard defines the triple point of water as 0.01°C. It has been recommended by the International Committee on Weights and Measures as the standard for the International Temperature Scale, and is already the standard on the thermodynamic scale (273.16K).



Phase Diagram for H_2O

The triple point of water is attained by partially freezing pure water in an evacuated and sealed glass system. A triple point of water cell maintains its true reference temperature of 0.01°C when ice, water and water vapor exist at 4.58 mm Hg.



Equiphase Cell

Triple Point Cells which meet the exacting requirements for use as a primary temperature standard are now available from Trans-Sonics, Inc. in a convenient, easy-to-use package. Called an Equiphase* Cell, this instrument is ideal for use in research laboratories, quality control and standards departments, or wherever a highly accurate and reliable primary temperature standard is required. Equiphase Cells come complete with full instructions for use, and are constructed so there is no possibility of contamination with consequent loss of accuracy. Write for Equiphase Cell Technical Bulletin to Trans-Sonics, Inc., Dept. 19, Burlington, Mass.

*T.M.

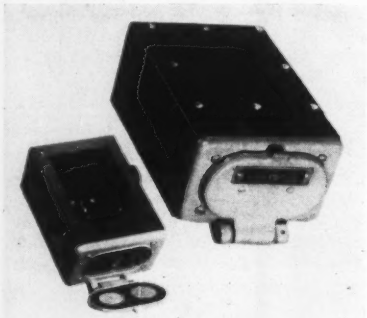
TRANS-SONICS T.M.

Precision Transducers

For more information circle **127** on inquiry card.

PUSHBUTTON STATIONS

New line of Merc-O-Matic weatherproof Pushbutton Stations with heavy-duty mercury-to-mercury con-

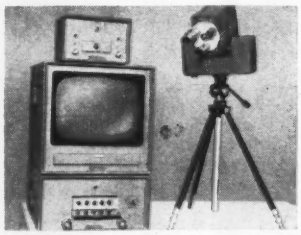


tacts has rated capacities up to 35 amps.—*Tigerman Engineering Co., 4332 N. Western Ave., Chicago 18, Ill.*

For more information circle **248** on inquiry card.

ITV

New line of closed-circuit TV consists of new and improved vidicon camera, monitor, and control unit. The camera features an entirely electronic light compensator. Precision-built accessories include remote con-

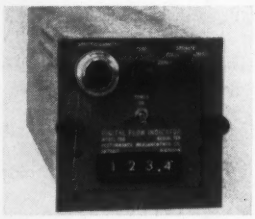


trols for optical focus, lens turret, zoom, iris, pan, and tilt, as well as special explosion-proof and weatherproof housings, distribution amplifiers, and multiple camera switches.—*Industrial Products Div., International Tel. & Tel. Corp., 15191 Bledsoe St., San Fernando, Calif.*

For more information circle **249** on inquiry card.

DIGITAL FLOW INDICATOR

New high-accuracy Digital Indicator, Model DFI-2, based on servo null-balance design, presents digital



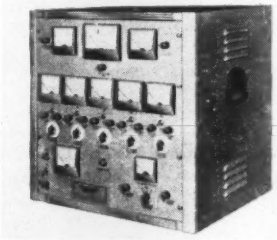
data directly in units of flow (gpm or lb/hr). Basic indicator accuracy is ±0.10% full scale. Input is from any turbine-type flowmeter with a

maximum frequency of 500 pulses/sec for full flow, fed directly to an integral frequency converter. Output of the frequency converter is a d-c signal proportional to flowmeter output frequency. Specific gravity range of the instrument is 0.2 to 1.2.—*Performance Measurements Co.*, 15301 *W. McNichols, Detroit* 35, *Mich.*

For more information circle **250** on inquiry card.

LOAD-DISTRIBUTION COMPUTER

New desk-top-size Belac load distribution Analog Computer provides instant, visual interpretation of operating data in public utility electric power systems. Among the varying

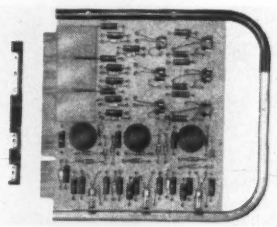


factors dealt with by the computer are turbine back pressure, spinning reserve data, cooling water temperature limitation, effects of hydrogenation, changes in fuel costs, and tie-in line sales.—*Belock Instrument Corp.*, 111*th St.* & 14*th Ave., College Point* 55, *N. Y.*

For more information circle **251** on inquiry card.

MAGNETIC-CORE MEMORY

New magnetic-core 3-C Memory System for digital data handling equipment incorporates transistorized plug-in packages, specifically designed to handle core matrix driving and sensing circuits. Random access



memories of up to 4096-word capacity and 40-bit word lengths are possible. Access time is 4 usec to any address, and cycle time between successive address locations may be as short as 8 usec. Basic core memory building blocks consists of sense amplifier (see photograph), current driver, inhibit driver and selection switch packages.—*Computer Control Co., Inc.*, 92 *Broad St., Wellesley, Mass.*

For more information circle **252** on inquiry card.

easily installed

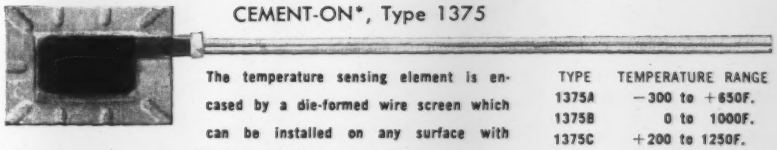
factory calibrated

TRANS-SONICS

REG. T.M.

SURFACE TEMPERATURE TRANSDUCERS

actual size

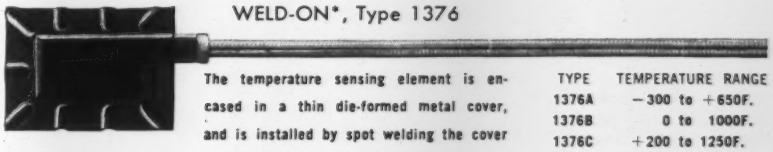


CEMENT-ON*, Type 1375

The temperature sensing element is encased by a die-formed wire screen which can be installed on any surface with TRANS-SONICS Type 64C cement.

TYPE	TEMPERATURE RANGE
1375A	−300 to +650F.
1375B	0 to 1000F.
1375C	+200 to 1250F.
1375D	+500 to 1550F.

actual size



WELD-ON*, Type 1376

The temperature sensing element is encased in a thin die-formed metal cover, and is installed by spot welding the cover to the underlying metallic surface.

TYPE	TEMPERATURE RANGE
1376A	−300 to +650F.
1376B	0 to 1000F.
1376C	+200 to 1250F.
1376D	+500 to 1550F.

- **RANGES:** From −400F to +1550F.
- **OUTPUT:** Up to 5 volts without amplification.
- **RESISTANCE CHANGE:** 100 ohms over calibrated range.
- **ACCURACY OF CALIBRATION:** ±1% of range interval ±2% for temperatures over 1000F.
- **MAXIMUM CONTINUOUS CURRENT:** 20 milliamperes rms.
- **REPEATABILITY:** ±0.2% of range interval.
- **VIBRATION:** 1-inch double amplitude, 0-22 cps; 25g, 22-2000 cps.
- **ACCELERATION & SHOCK:** 100g on all three major axes.
- **LEADS:** Two 6" nickel wires with high temperature insulation.

Trans-Sonics Cement-On Type 1375 and Weld-On Type 1376 Surface Temperature Transducers are platinum resistance thermometers that can be installed on any surface, flat or curved, metallic or non-metallic, for accurate temperature measurement. The protective cover of the resistive element is cemented or welded directly to the thermal surface to form an isothermal system which gives a transducer reading that corresponds to the true skin temperature.

A 5 point resistance-temperature calibration certificate at 0, ¼, ½, ¾ and full scale temperature is supplied with each transducer. A strip of aluminum Thermotape* is also furnished with each unit to provide an alternate means of tape-on installation useful to 800F and under limited conditions to 1000F.

Types 1375 and 1376 are the newest members of the Trans-Sonics family of platinum resistance thermometers for measuring surface temperatures. All units are capable of delivering up to 5 volts without amplification. Write to Trans-Sonics, Inc., Dept. 19, Burlington, Mass. for Technical Bulletin on Surface Temperature Transducers.

*TRADEMARK

TRANS-SONICS

Precision Transducers

For more information circle **128** on inquiry card.

Better GOW-MAC DETECTORS for VPC
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because every GOW-MAC unit is GAS TESTED for—

- **ZERO DRIFT**
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OTHER GOW-MAC PRODUCTS—Portable and Panel Instruments, Power Supplies (20V 500 ma DC) On Stream T/C Cells (Hot Wire and Thermistor), Hot Wire Filaments in matched pairs from stock. Address inquiries to Dept. IA.

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For more information circle **129** on inquiry card.

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* Textile Machinery will not be shown at 1959 Fair

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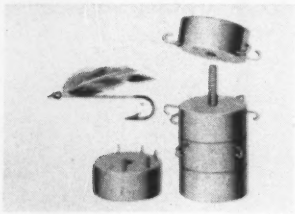
For more information circle **130** on inquiry card.

NEW INSTRUMENTS

MINIATURE TRANSFORMER

New miniature 1.0-watt Toroidal Power Transformer is fully encapsulated and hermetically sealed, and meets test specs of MIL-E-5272 and MIL-T-27A. Units can be supplied



with a primary voltage of 115 v, 400 cps. and secondary voltage from 1 to 100 v, 400 cps.—Data Sheet 8-1 contains details.—*Arnold Magnetics Corp., 4613 W. Jefferson Blvd., Los Angeles 16, Calif.*

For more information circle **253** on inquiry card.

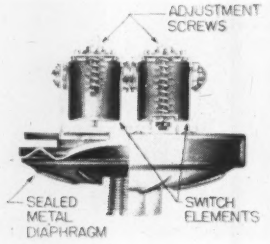
LEVEL CONTROLLERS

New Models A-102-F and A-103-F Level Controllers for flanged mounting, and A-102 and A-103 for screwed mounting, are for specific gravity ranges beginning at 0.5, depending on the type displacers used. Displacers can be of glazed porcelain (standard), or Karbate, chemically inert impregnated carbon. Stainless steel displacers can be supplied with Model A-103-F.—*Magnetrol, Inc., 2110 S. Marshall Blvd., Chicago 23, Ill.*

For more information circle **254** on inquiry card.

PRESSURE/VACUUM SWITCH

New stripped Model 404 dual-setting Pressure and Vacuum Switch features high repetitive accuracy. Recommended for liquid, gas or water systems, this new series is avail-

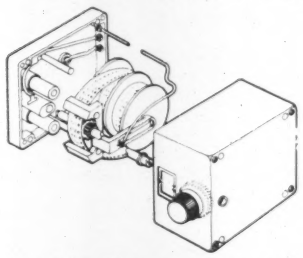


able in proof pressures of 30 vacuum to 150 psig. It accurately senses any two pressures in the same system over an adjustable range of 30" Hg to 100 psig, and actuates two independent electric circuits. U.L. listed single-pole double-throw switching elements for a-c and d-c circuits are automatically reset by the snap-action of the switches.—*Barksdale Valves (Pressure Switch Div.), 5125 Alcoa Ave., Los Angeles, Calif.*

For more information circle **255** on inquiry card.

SLIDEWIRE-TAPE POT

New multi-turn potentiometer, TA'POT H5600, has a resistance wire bonded within the edge of a laminated Mylar tape. With the calibration stamped on the tape, any linear or non-linear calibration is obtainable including direct digital reading of

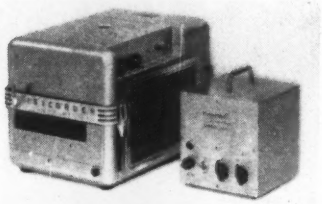


temperature with any type of thermocouple, square root extraction when used with differential pressure transducers for flow measurement, and hyper-bolic and logarithmic functions encountered in analysis and radiation systems. Conformity between true resistance value and the specified function of the calibration is 0.05%, resolution is better than 0.01%, total resistance tolerance 0.25% and end resistance less than 0.005 ohm. Power rating is 2 watts at 25°C. Readout is direct through a window on the front of the case.—*Howell Instrument Co., 3101 Trinity St., Fort Worth 7, Texas*

For more information circle **256** on inquiry card.

RECORDING OSCILLOGRAPHS

New models in the 906-Series of direct-reading Visicorders provide higher recording frequencies and increased channel capacities: The 906A-1 features high-sensitivity miniature plug-in galvanometers and magnet assembly, which permit 14 channels of data to be recorded directly at fre-



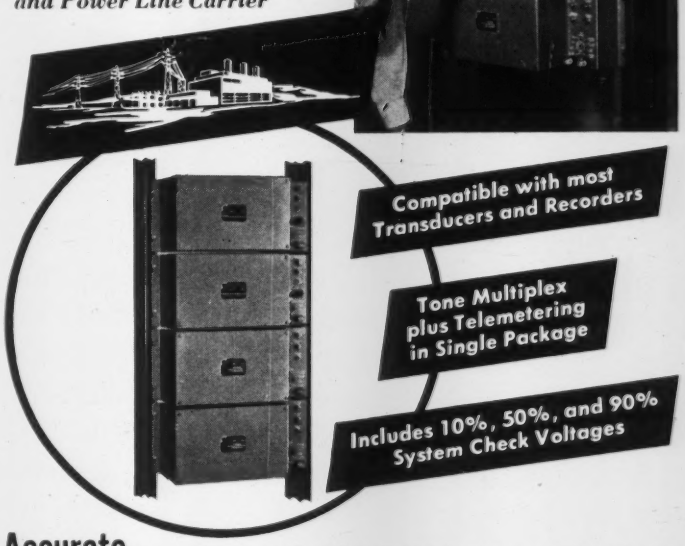
quencies from dc to 5000 cps. The 906A-2, with "solid-frame" galvanometers and magnet bank, provides for 8-channel recording at frequencies from dc to 2000 cps. Besides, a new timing unit, which is a separately-housed multivibrator oscillator, provides short, accurately spaced pulses to timing of 0.01, 0.1, or 1.0 sec; and a latensifier provides legible records within a few seconds. This unit consists of a record takeup unit with drive motor and removable spool.—*Minneapolis-Honeywell, Industrial Products Group, Heiland Div., 5200 East Evans Ave., Denver 22, Colo.*

For more information circle **257** on inquiry card.

REMOTE INSTRUMENTATION & CONTROL

Telemeter
CONTINUOUSLY
from Remote Points

Accurate, Fast Acting, Frequency Type Telemeter for Transmission over Wire Lines, Microwave, and Power Line Carrier


Compatible with most Transducers and Recorders
Tone Multiplex plus Telemetering in Single Package
Includes 10%, 50%, and 90% System Check Voltages

Accurate HIGH-SPEED Analog Telemeter for VOLTS AMPS WATTS PRESSURE FLOW TEMPERATURE etc.

The Model 1025 Telemeter Transmitter converts DC mv from thermal converters, or other transducers with a DC mv output, to an output of 10 to 30 cps. If multi-channel operation over a single communication circuit is required, the 10 to 30 cps signal is used to modulate a built-in frequency shift tone channel. The Model 1090 Telemeter Receiver detects and demodulates the transmitted signal and generates a DC current or voltage which varies in exact accordance with the telemetered functions. The receiver output may be directly applied to either recorders, indicating instruments, or both.

The equipment is conservatively designed for continuous duty operation. The over-all accuracy of the Telemeter is 1% with a speed of response of one second.

WE CAN HELP YOU — Our Applications Department is ready to assist you in your control, telemetering or communications problem.

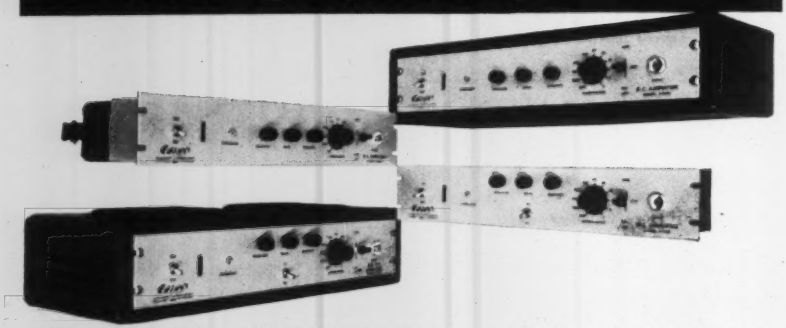
SEND FOR TECH. DATA

For additional information, including application data, write or phone DE 4-3100. Demonstrations available by local representatives.

Radio Frequency LABORATORIES, INC.
Boonton, New Jersey, U.S.A.

For more information circle **131** on inquiry card.

New EDIN B-SERIES
Oscillograph Amplifiers



EDIN has met these specs—ARE THEY YOURS?
• **GAIN:** to 100,000 • **STABILITY:** Down to 10 μv equivalent input drift/hr. • **FREQUENCY RESPONSE:** DC to 1500 cps ±1% • **INPUT IMPEDANCE:** 2 megohms, for use with wide variety of transducers • **REJECTION RATIOS:** Better than 20,000 to 1 • **CALIBRATION:** Internal • **PACKAGING:** Standard 19" rack-panel or portable case

Edin's new line of maximum stability oscillograph amplifiers provides precise amplification of signals over an extremely wide measurement-level spectrum.

Whether you want to measure a brain-wave or the crushing force of a 20-ton press . . . the efficiency parameters of an air gage or a welding machine, one of the B-Series special purpose amplifiers will handle the job to perfection.

Write now for complete technical data on the entire line of Edin Oscillograph Recording Instrumentation.

Edin

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For more information circle **132** on inquiry card.

ACCURACY
in modern scientific instruments often depends on controlling the direction of light without:

DISTORTION • DIFFRACTION

DIFFUSION

Consult the pioneers in evaporated metal coatings for:

- first surface mirrors with half-wave protection
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Send for our free booklet. We have experience and skill to put at your service in solving your individual light problem.

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For more information circle **133** on inquiry card.

NEW INSTRUMENTS

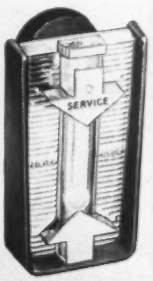
PROPORTIONING PUMP

New Series 100 Simplex models handle capacities ranging from 0.65 gph to a maximum of 13-10 gph at a maximum pressure of 1000 psi. Duplex Series 100 models are rated at double the capacities of the Simplex models. Capacity regulation is provided by screw adjustment on the crank which adjusts the stroke from 0 to a maximum of 1½". Repetitive metering accuracy within a tolerance of ±1% is obtained when the pump operates between the limits of 10% to 100% of stroke length.—*American Meter Co., Pump Div.,* 13500 *Philmont Ave., Phila.* 16, *Pa.*

For more information circle **258** on inquiry card.

FILTER GAGE

New Filter Gage, actuated by differential between atmospheric and blower compartment pressures, indicates the gradual clogging of filter

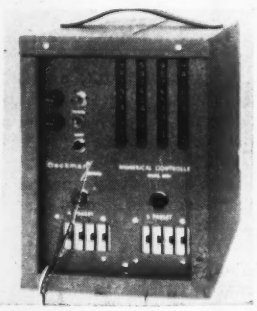


and exact time for service. Three different capacities fit all types and sizes of furnaces, air-conditioning systems, room coolers, etc.—*F. W. Dwyer Mfg. Co., Dept. No. IAA P. O. Box* 373, *Michigan City, Ind.*

For more information circle **259** on inquiry card.

NUMERICAL CONTROLLER

New Model 5800 Series counter-controllers employ miniature magnetic



amplifiers for trouble free service in industrial control applications. Will count a total of 100,000 events at max.

rate of 5000/sec. Solid-state transducers supply input information. Outputs are relay contact closures rated at 5 amps. Is protected by a dust tight housing and accommodates standard conduit connections.—*Berkeley Div., Beckman Instruments, Inc.*, 2200 *Wright Ave., Richmond* 3, *Calif.*

For more information circle **260** on inquiry card.

TEMPERATURE INDICATOR

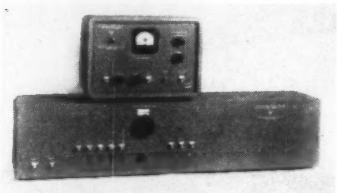
New Thermophil Electronic Industrial Thermometer has thermistor probes which are made in more than

100 different shapes. They assure unusually rapid response and temperature measurements between -60° to +845°F. Response times (time constant) are 0.72 sec in liquids and 2.2 sec on surfaces, or 5 and 15 sec respectively, for full readings. Accuracy is within 1% of scale range. Readability on portable indicator is ½° or better on extra-length scales in three overlapping steps. Instrument is made in West Germany.—2-page bulletin gives details.—*Atkins Technical, Inc.*, 709 *Marion Bldg., Cleveland* 15, *Ohio.*

For more information circle **261** on inquiry card.

H-F PHASE METER

New type 205B high-frequency phase meter consists of a phase indicator unit, indicating the condition when both input signals are in phase or 180° out of phase, and a time de-



lay unit, composed of a coaxially-constructed continuously-variable delay line and two coaxial step-variable delay lines. Operating frequency range is 15 Mc to 500 Mc. Accuracy, 1% to 200 Mc, 2% at 500 Mc. Characteristic impedances are 50 ohms for input and output with BNC connectors. Attenuation is 0.5 db musec at 200 mc and 0.07 db musec at 500 Mc.—*Ad-Yu Electronics Lab., Inc.*, 249 *Terhune Ave., Passiac, N. J.*

For more information circle **262** on inquiry card.

each industry has one major industrial show--

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FIFTH INTERNATIONAL AUTOMATION EXPOSITION AND CONGRESS

In just six years, the Automation Exposition has achieved recognition as the *one* automatic production show which attracts the *top* technical and management personnel of all industries.

You'll find no better showcase for your equipment for automation than at the Fifth International Automation Exposition and Congress, November 16 to 20, 1959, New York Trade Show Building.

Plan now to exhibit—write for exhibit and program details, and breakdown of attendance at previous shows.

Richard Rimbach Associates, Management
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For more information circle **134** on inquiry card.

TORQUE METER SYSTEMS
ACCELEROMETERS
BRIDGE BALANCE AND CALIBRATING UNITS AND TRANSDUCER INPUT CONDITIONING EQUIPMENT

Typical B & F products widely employed in industrial, missiles and aircraft test facilities.

MULTI-CHANNEL STRAIN GAGE RECORDING AND PLOTTING SYSTEMS

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GArfield 5-4175

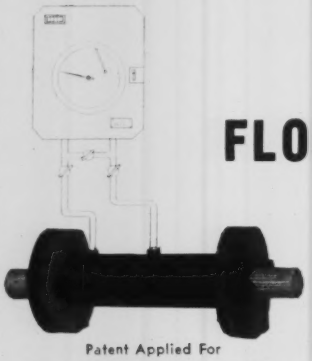
Inquiries also invited re representation in Chicago, Denver or Albuquerque, Atlanta or Orlando, Dallas—Fort Worth, Louisville—Nashville.

For more information circle **135** on inquiry card.

Introducing

the new

MASS FLOWMETER FOR GASES



Patent Applied For

Metering and controlling mass flow rate of gases is easy and simple with the new NIL primary element.

- Element is an orifice whose area is controlled by pressure and temperture.
- **Convert** your present system to mass flow metering or controlling by substituting the NIL element for the orifice or venturi.
- **Easy Installation** in line with no offset, the element is as easy to install as a valve.
- **Rugged** and trouble free, the element has no rotating parts.
- **Automatic**, the density compensation is made by a stainless steel bellows and requires no electrical or other auxiliary power.
- **Complete** metering or controlling system or primary element alone is available.

NATIONAL INSTRUMENT LABORATORIES, INC

828 Evarts St., N.E. • **Washington, D.C.**

WRITE FOR BULLETIN 178.

For more information circle **136** on inquiry card.

new plants and mergers

MAROTTA VALVE CORP. announces a new 20,000-sq-ft plant addition.

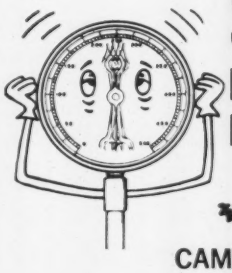
ALLIS-CHALMERS' purchase of **S. MORGAN SMITH CO.** has been approved. The York, Pa., firm and its subsidiaries will operate as A-C's newly created Hydraulic Division within the Industries Group.

INDUSTRIAL INSTRUMENT CORP. recently opened its new West Texas Division in Odessa.

DAYSTROM-WESTON DIV. of Daystrom has formed an integrated sales organization responsible for the products of the three units of Daystrom, Inc.

MANNING, MAXWELL & MOORE will relocate the Nuclear Products Department to Watertown, Mass., and the manufacture of electronic process control instruments to Stratford, Conn.

BALDWIN-LIMA-HAMILTON CORP. Electronics & Instrumentation Div. announces that national distribution of SR-4 strain gages will be transferred entirely from local Corporation sales offices to Industrial Sales Representatives. Other SR-4 products manufactured by the E & I Division will still be handled through the local sales offices of B-L-H.

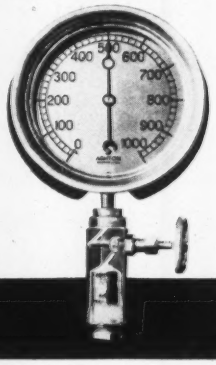


SURE CURE for HEADACHES DUE TO PRESSURE GAUGE JITTERS

CAMPBELL MICRO BEAN

UNIVERSAL PULSATION DAMPENER

A Campbell Micro-Bean cures a headache ten times as fast as aspirin provided the headache is caused by a pressure gauge with a bad case of the jitters. Rapidly becoming the standard pulsation dampener in many industries all over the world.



Write for Literature -

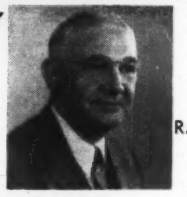
J. A. CAMPBELL COMPANY
645 East Wardlow Road
Long Beach 7, California

For more information circle **137** on inquiry card.

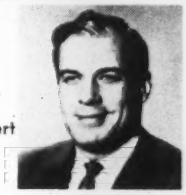
EASTERN AIR DEVICES has been merged into **NORBUTE CORP.** division of Crescent Petroleum Corp.

BURROUGHS CORP. will start construction of a new $2,000,000 engineering and administration building at its military electronic computer plant.

people in the news



I. M. Stein



R. J. Hippert

LEEDS & NORTHRUP's president, *I. Melville Stein*, has just completed his fortieth year with the company. He joined the organization in 1919 as a sales engineer, and moved up through various responsibilities which included a long period as director of research. In 1951 he was elected to the new position of executive vice president, and two years later he became president.

CANNON ELECTRIC CO. has announced appointment of *Ralph J. Hippert* as its new advertising manager.

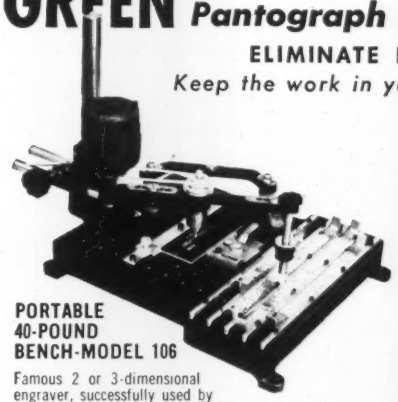
FISHER GOVERNOR CO. announces that, beginning with the new year, *W. J. Bestmann* assumes management of the **CONTINENTAL EQUIPMENT** division.

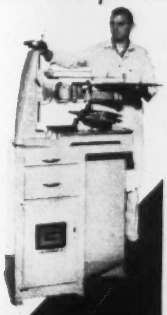
ESPCO, INCORPORATED announces appointment of *Orville E. Orbom* as assistant vice president of industrial marketing.

GREEN *Pantograph Engravers*

ELIMINATE DELAYS!

Keep the work in your own plant.





PORTABLE 40-POUND BENCH-MODEL 106

Famous 2 or 3-dimensional engraver, successfully used by thousands, features 5 positive, accurate pantograph ratios. Versatile ball bearing spindle has three speeds up to 14,000 rpm; height of pantograph and position of cutter are continuously adjustable; one copy carrier (supplied) accepts all standard master type sizes.

The Model 106 has proven incomparable for speed and accuracy . . . yet reasonably priced.

Cutter grinders, rotary tables, master letters, compound slides, name plates and all required accessories. For complete information, write to

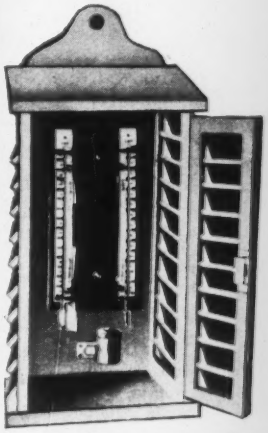
MODEL D2 HEAVY-DUTY 2-DIMENSIONAL

- 575 pounds . . . rig'd, sturdy, precise
- Vertical adjustment of copy table automatic with Pantograph
- Unobstructed on three sides to take large work
- Micrometer adjustment for depth of cut
- Ball-bearing construction throughout . . . super-precision ball bearing spindle
- Spindle speeds up to 26,000 rpm for engraving or machining modern materials
- Ratios 2 to 1 to infinity
- master copy area 26" x 10"
- Vertical range over 10"

GREEN INSTRUMENT COMPANY, INC.

383 PUTNAM AVENUE, CAMBRIDGE 39, MASS.

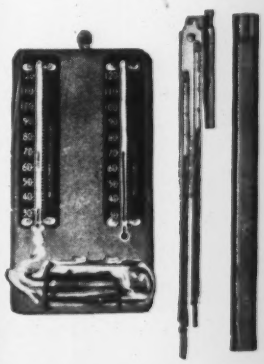
For more information circle **138** on inquiry card.



True or False?

It's not the heat it's the humidity.

...It's both as measured by MOELLER Psychrometers



These dependable Moeller instruments have received general acceptance for determining relative humidity regardless of climatic conditions. Equipped with two accurate thermometers and easy reading chart. Weather Bureau and Mason's Form, as well as Sling Types, which are available in various ranges and in two sizes, the smaller being the pocket size.

Order your supply of these precision instruments now — Mail the coupon for complete details.

MOELLER INSTRUMENT COMPANY SINCE 1867

132nd ST. and 89th AVE. • RICHMOND HILL 18, N. Y.

Representatives in Principal Cities

Gentlemen: Without obligation, please send me Catalog No. 150 on Moeller Psychrometers.

NAME .....

FIRM .....

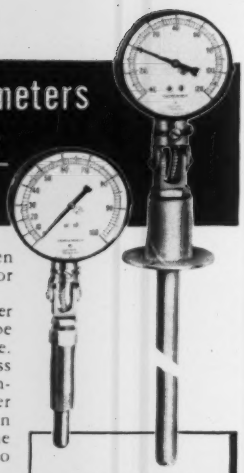
ADDRESS .....

CITY ..... ZONE ..... STATE .....

For more information circle **139** on inquiry card.

New!

Marsh Dial Thermometers *designed expressly* for piping and ducts



Here you have everything that has been so long needed in thermometers for piping and duct work.

Big 3½" and 4½" dials are far easier to read; still more important, can be turned and tilted to *any* reading angle.

Instead of illegible, breakable glass tube, you now have the readable, unbreakable Marsh—the thermometer that gives greater *readable* accuracy than any glass tube thermometer and has the famous Marsh "Recalibrator" to *keep* it accurate.

Complete line provides for every service. Separable sockets and swivel attachment nuts make connecting and disconnecting easy. Extension necks provide for insulated piping and ducts.

FOR PIPING

Ranges: 0°—100° F, 20°—120° F, 40°—240° F and 100°—300° F. ¼" NPT male connection.

FOR DUCTS

Ranges: minus 40°—120° F, 0°—160° F, 0°—220° F. Long stems extend into ducts for accurate indication.

Also available in remote reading types with 6 ft. tubing. Same ranges, sockets, stems, dial sizes.

New bulletin covers interesting details

Jas. P. Marsh Corporation
Dept. 42, Skokie, Illinois

MARSH

For more information circle **140** on inquiry card.

Opportunities at

Esso Research & Engineering Company

Chief Technical Affiliate—Standard Oil Company (New Jersey)

INSTRUMENT ENGINEERS

EE, ME or ChE (BS, MS, PhD)

Application of instrumentation and automation techniques to all phases of petroleum industry operation. Opportunity for travel as consultants on new techniques and equipment application. Experience in instrumentation field required.

Give full details of education, experience, desired salary and references. All inquiries will be considered promptly and held confidential.

Address replies to:

ESSO RESEARCH AND ENGINEERING COMPANY
ESSO RESEARCH CENTER
Employee Relations—Y, P. O. Box 175
Linden, New Jersey

PEOPLE—CONTINUED

GENERAL PRECISION LAB. has promoted *Richard W. Lee* to vice president, engineering and research; and *Wiliam P. Hilliard* to vice president, administration and manufacturing.

ROBERTSHAW-FULTON CONTROLS CO. has named *W. J. (Jim) Chadburn* manager of field operations, electronics, at the Aeronautical and Instrument Division; and *George H. Crock* works manager of the newly formed Indiana Division.

BENDIX AVIATION CORP's new appointments include *John W. Hammond* as assistant director of engineering, and *Russell B. Stevenson* as general sales manager of the Friez Instrument division; and *John R. Harkness* as electronics manager of Bendix-Pacific division.

NEELY ENTERPRISES held its annual sales conference in January which brought together a group of 35 field engineers. Front row left, with glasses, is *Norman Neely*, president; immediately to his left, hands folded, is *Robert Boniface*, sales manager.

King MANOMETERS

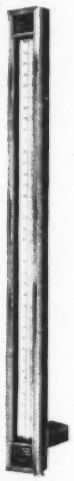
For Plant and Laboratory

King Manometers are rugged, low-cost instruments of unexcelled accuracy for measuring pressure, vacuum, differential pressure, and pressure-related phenomena. They're available in the following types, in a complete range of sizes:

U-Type Manometers
- Single Cleanout
- With 3-Valve Manifold
- Double Cleanout
- Inverted U-Type

Well-Type Manometers
- Low-Well
- Barometric-Reading
- Raised-Well
- Flowmeter Type
- Inclined-Tube

Multi-Tube Manometers
- Individual-Well
- Common-Well
- Photo-Manometers



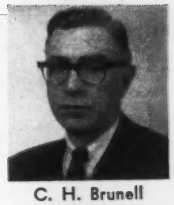
NEW CATALOG 2008 gives details on these and other models—includes manometer liquids and accessories—explains basic principles. Write—

KING ENGINEERING CORP.
Box 70 • Ann Arbor, Mich.
REPRESENTATIVES IN PRINCIPAL CITIES

For more information circle **141** on inquiry card.

I. R. Schwartz

R. D. Hannan



C. H. Brunell

M. I. Steinberg

L. J. Patterson

R. L. Woizeski

SWARTWOUT CO. has appointed *Irving R. Schwartz* field sales manager of the Autronic Division.

SAMA announced that *Richard D. Hannan* has been appointed executive secretary of the industrial instrument section.

CENTURY ELECTRONICS & INSTRUMENTS, INC. announced appointment of *Charles H. Brunell* as vice president-sales.

SENSITIVE RESEARCH INSTRUMENT CORP. announces appointment of *Marvin I. Steinberg* and *Leonard J. Patterson*, as executive vice presidents and members of the board of directors.

HELICOID GAGE Div., American Chain & Cable Co. has assigned *Roger L. Woizeski* to handle sales and engineering of pressure instruments in Maryland, Delaware, Virginia, Washington (D. C.), Philadelphia and Camden.

OPTICS

A. D. JONES OPTICAL WORKS

2400 MASSACHUSETTS AVENUE
CAMBRIDGE 40 MASSACHUSETTS
TRowbridge 6-3368—3369

A LIST OF MATERIALS WE FABRICATE USED IN OPTICS AND ELECTRONICS

SAWING GRINDING POLISHING DRILLING

ALUM
ALUMINA
ALUMINUM
ANTHRACENE
ARSENIC TRISULPHIDE
BARIUM TITANATE
BISMUTH
BRASS
CARBORUNDUM
CERAMIC
COBOLT FERRITE
COPPER
*CORNING 707
*CORNING 7052
CUPROUS BROMIDE
FERRITE
FERROX
**FLUORIDE, CALCIUM
**FLUORIDE, LITHIUM
GALLIUM ANTIMONIDE
GALLIUM ARSENIDE
GARNET
GERMANIUM
GOLD
INDIUM ANTIMONITE
INDIUM PHOSPHIDE
INDOX
IRON SINGLE CRYSTAL
LITHIUM FERRITE
MAGNETIC PLUMBITE
MELAMINE FIBER GLASS
MICA, SYNTHETIC
NICKEL OXIDE
PLATINUM
POTASSIUM BROMIDE
*PYREX
*QUARTZ, CRYSTAL
*QUARTZ, FUSED
**SAPPHIRE
**SODIUM CHLORIDE
**STEEL
STRONTIUM TITANATE
TEFLON
TITANIUM DIOXIDE
*VYCOR
*X-RAY LEAD GLASS
ALL TYPES KNOWN GLASS

* Carried in stock
** Purchased for orders

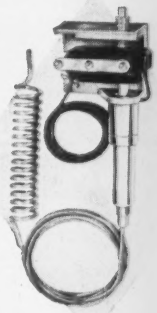
For more information circle **142** on inquiry card.

Improved Design

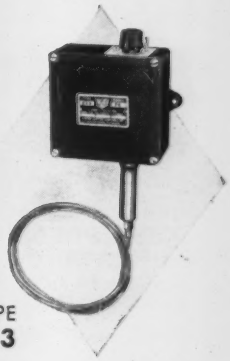
REMOTE BULB TEMPERATURE CONTROLS

F56 E13

WIDE RANGE CALIBRATED



TYPE F56



TYPE E13

The F56 and E13 are functionally similar controls. Type F56 is a wide range, uncalibrated, skeleton unit designed for use in ovens, incubators, and other applications where space or weight is a limiting factor. Type E13 is a narrow range, calibrated, enclosed unit intended for similar applications but under conditions where an enclosure and external adjustment knob and dial are desirable. Explosion proof unit, Type E98, is also available.

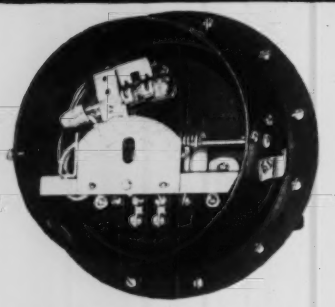
Temperature Ranges	F56 . . . up to maximum limits of −150° to +150° F, 70° to 370° F, or 100° to 650° F. E13 . . . 100° or 200° spans between −150° and +650° F limits.
Switch Ratings	15 or 20 amps at 115 or 230 volts AC. DC switches also available.
Switch Types	N.O., N.C., or Double Throw, no neutral position.
Adjustments	F56 . . . slotted range adjustment screw on top, uncalibrated settings. E13 . . . external knob and pointer, calibrated settings.
Electrical Connections	F56 . . . 12-inch lead wires attached directly to switch terminals. E13 . . . to internally located terminal block via conduit opening in enclosure.
Capillary Tube Length	6-foot standard length. Other lengths available.
Mounting	E13 . . . surface mounted in any position by means of dog ears. May be flush mounted. F56 . . . Surface mounted in any position by holes drilled in base of bracket. May be flush mounted.

UNITED ELECTRIC *manufactures a complete line of temperature, pressure, and vacuum controls. For additional data on the remote type temperature controls, including types F56 and E13, request* Section 200 *of our* new *catalog.*

UE® United Electric Controls COMPANY
83 SCHOOL STREET, WATERTOWN, MASS.

For more information circle **143** on inquiry card.

new instrument



FM APPROVED

LOW PRESSURE DIAPHRAGM CONTROL

For Air or Gases

This FM approved (Mercoid Type PG) control can be used three different ways; for positive pressure; negative pressure (vacuum); for differential pressure or vacuum.

OPERATING RANGE 1.0" to 30.0" (H_2O)

FIXED DIFFERENTIAL (Sensitivity)
When operating point is set at

Low	Med.	High
0.6"	0.8"	1.0"

MAXIMUM PRESSURE 20 psig

Equipped with Fairprene diaphragm, external adjustments, hermetically sealed mercury switch—case made of heavy gauge steel (NEMA 1)

Available fully automatic or semi-automatic with manual reset.

Write for Bulletin PG to The Mercoid Corporation, 4231 Belmont Ave., Chicago 41.

FM APPROVED

HIGH TEMPERATURE LIMIT CONTROL

Mercoid Type MX-51R for use with dryers, ovens, furnaces, etc. This adjustable indicating type high temperature limit control is actuated by a coiled bimetal element to result in a normally closed mercury (tube type) switch opening in event the supervised temperature reaches the preset limit point. A manual reset knob is arranged to reset mercury switch after high temperature operation and normal temperature restoration.

Operating Range (adjustable) 50-650° F. Minimum Differential 20° F. Electrical Rating 10A. 115V. 5A. 230V.

Has independent adjustments for setting both high and low operating points; visible calibrated dial; sealed mercury contact, reversible mounting flange. Case made of heavy gauge steel (NEMA 1)

Write for Bulletin SEB-51 to The Mercoid Corporation, 4231 Belmont Avenue, Chicago 41, Illinois.

SPECIFY

MERCOID® CONTROLS

For more information circle **144** on inquiry card.

new literature

CONTROL SYSTEMS

PROCESS CHROMATOGRAPH. Model 26-202, is described with graphs in 10-page Bulletin 1836C.—Consolidated Electrodynamics, Analytical and Control Instrument Div., 300 North Sierra Madre Villa, Pasadena, Calif.

For more information circle **263** on inquiry card.

PANEL CONTROL SYSTEMS.—4-page Folder 5803-A describes pre-wired, pre-tested panel control systems for automatic oil, gas or dual-fuel burners in commercial and industrial boiler installations.—Iron Fireman Mfg. Co., 3170 West 106th St., Cleveland 11, Ohio.

For more information circle **264** on inquiry card.

POWER PACKS. 8-page Bulletin 765A, "A New Approach to Practical Control," gives complete engineering data and describes typical applications of Regatron programmable power packs. Electric Measurements Co., Inc., Eatontown, N. J.

For more information circle **265** on inquiry card.

VALVES AND ACTUATORS

VALVES. 20-page Catalog 59-60 is divided into sections according to the type of medium used (oil, water, or air), and features manual, foot-operated, and solenoid valves.—Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.

For more information circle **266** on inquiry card.

BUTTERFLY VALVES. Class 125 AWWA, are described in new 2-page Bulletin 650.20-1.—B-I-F Industries, Inc., 345 Harris Ave., Providence 1, R. I.

For more information circle **267** on inquiry card.

SURGE RELIEF VALVES. 8-page Bulletin W-2-A describes surge relief valves for protecting water lines against overpressures in the system.—Golden Anderson Valve Specialty Co., 1285 Ridge Ave., Pittsburgh 33, Pa.

For more information circle **268** on inquiry card.

PLUG VALVE ACTUATORS. 24-page binder contains drawings, descriptions, engineering data, and applications of air-operated plug valve actuators.—Pantex Mfg. Corp., Pawtucket, R. I.

For more information circle **269** on inquiry card.

TEMPERATURE

TEMPERATURE CONTROLS, mercury actuated, for in-transit refrigeration are described in 2-page Bulletin 1088.—The Partlow Corp., New Hartford, (Utica), N. Y.

For more information circle **270** on inquiry card.

THERMOWELL MATERIAL GUIDE.—4-page Thermowell Material Guide lists over 325 different temperature measuring applications.—Thermo Electric Co., Inc., Saddle Brook, N. J.

For more information circle **271** on inquiry card.

TEMPERATURE INDICATORS. 4-page bulletin describes Series BH 180 Autotemp temperature indicators with continuous digital reading from thermocouple input.—B & H Instrument Co., Inc., 3479 West Vickery Blvd., Fort Forth 7, Texas.

For more information circle **272** on inquiry card.

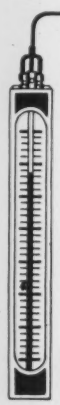
FLOW, PUMPS

ROTAMETER TRANSMITTER. 12-page Bulletin 170 describes (in building-block style) the design features of the MPT motion position transmitter.—Brooks Rotameter Co., Box 432, Lansdale, Penna.

For more information circle **273** on inquiry card.

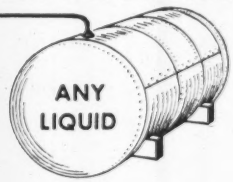
VACUUM PUMPS, with digests of articles on Low Pressure Gas Viscosity, Upper Atmospheric Densities, etc. are subjects in 4-page issue of "Vacuum Technology," Vol. 1/No. 3.—W. M. Welch Scientific Co., 1515 Sedgwick St., Chicago 10, Ill.

For more information circle **274** on inquiry card.



TANK-O-METER

FOR MEASURING TANK CONTENTS ANY DISTANCE AWAY



TANK MAY BE BURIED, ELEVATED, OPEN, CLOSED, VENTED OR UNDER PRESSURE OR VACUUM

SEND FOR BULLETINS

Also gauges for:
Barometric Pressure (Mercury Column)
Absolute Pressure (Mercury Column)
Pressure and Vacuum
Differential Pressure
Inclined Manometers for draft, pressure or differential pressure.

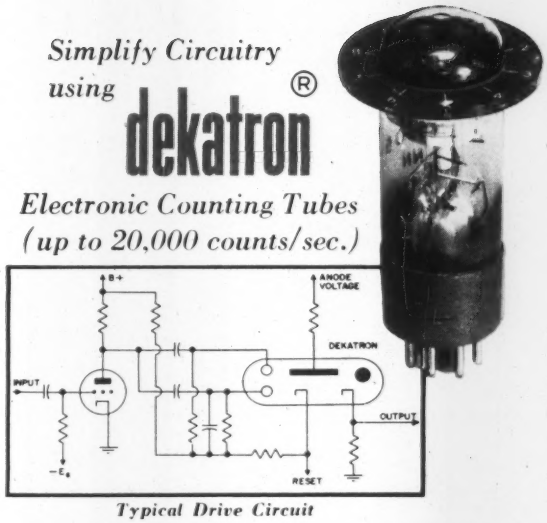
UEHLING INSTRUMENT CO. 470 GETTY AVE., PATERSON, N. J.

For more information circle **145** on inquiry card.

Simplify Circuitry using

dekatron®

Electronic Counting Tubes (up to 20,000 counts/sec.)



Typical Drive Circuit

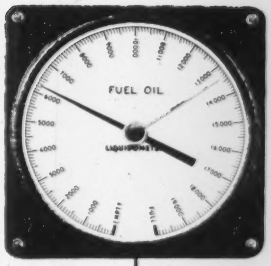
As a user of DEKATRON cold cathode glow-transfer counting tubes, you are welcome to use this and many other drive circuits designed by us. Circuits are patented (or applied for) but are available to DEKATRON customers on a royalty-free basis.

Write to us for complete information.

Baird-Atomic, Inc.
33 UNIVERSITY RD., CAMBRIDGE 38, MASS

Instrumentation for Better Analysis

For more information circle **146** on inquiry card.

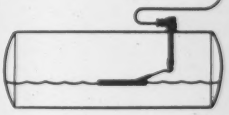


100% AUTOMATIC TANK GAUGING

Dependable remote reading tank contents gauges using a closed hydraulic transmission system. No power required.

Several sizes available. Approved by Underwriters Laboratories and Factory Mutual. UL approved switches.

Write for complete details, to Dept. E



Since 1920 of proven quality

THE LIQUIDOMETER CORP.
LONG ISLAND CITY 1, NEW YORK

For more information circle **148** on inquiry card.

---

new...

THE Dwyer

Filter Gage

tells exactly when to change filters...
lasts indefinitely...
fits all furnace and air conditioning units...

one hole, 60 second installation

Individually packaged with display/merchandising counter sales carton. A foolproof filter gage that really works, sold on a satisfaction or money-back guarantee. Write for free sample and discounts.

F. W. DWYER MFG. CO.
P. O. BOX 373-S MICHIGAN CITY, INDIANA

For more information circle **147** on inquiry card.

READ any surface temperature with Alnor PYROCON

Equipment...material...metallic or non-metallic...flat, curved... revolving or stationary—you can read every surface temperature accurately in less than 3 seconds!

Compact, complete in precision design, this rugged instrument assures highest standards of speed, accuracy and dependability.

Alnor Portable Pyrocons come in scale ranges to 2000° F., with thermocouples for every application. You'll find full details on the Pyrocon exactly suited to your operations in Bulletin 4257. Send for your copy now. Write: Illinois Testing Laboratories, Inc., Room 518, 420 N. LaSalle St., Chicago 10, Ill.

Alnor

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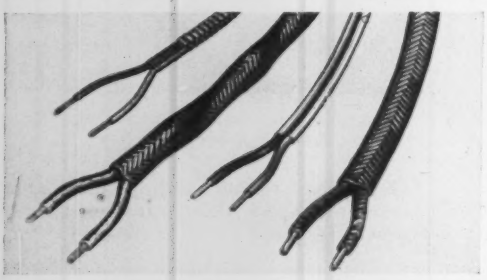

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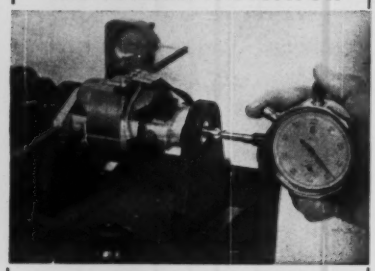

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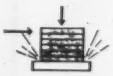
For more information circle **152** on inquiry card.

NEW LITERATURE

GAS METERS. 4-page Bulletin 310 provides complete details on the capacities, construction and performance of Types 25B and 35B Ironcase Meters.—American Meter Co., 920 Payne Ave., Erie, Pa.
For more information circle **275** on inquiry card.

PURGE METER, a variable area flowmeter featuring a corrosion-proof fiber glass housing and a metering tube that "snaps-in," is described in new Spec. Sheet 10A3135.—Fischer & Porter Co., 849 Jacksonville Rd., Hatboro, Penna.
For more information circle **276** on inquiry card.



PRESSURE, WEIGHT

PRESSURE TRANSDUCERS for aircraft and missiles are described in new 8-page Bulletin ADC-162.—Minneapolis-Honeywell Regulator Co., Aeronautical Div., 2600 Ridgway Rd., Minneapolis 13, Minn.
For more information circle **277** on inquiry card.

RATIO COUNTING SCALE. 2-page Specification Sheet G618 illustrates and describes scales for counting and weighing parts as small as 0.01 oz "by a simple load and look operation."—Detecto Scales, Inc., 540 Park Ave., Brooklyn, N. Y.
For more information circle **278** on inquiry card.

PRESSURE TRANSDUCERS. Three 2-page bulletins describe (1) Model DP-7 pressure transducer (No. 58-131), (2) Model GP-15D high-range pressure transducer (No. 58-140), and (3) Model DP-15D high-range differential-pressure transducer (No. 58-135).—BJ Electronics, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif.
For more information circle **279** on inquiry card.

TIME

TIME ANNOUNCERS. 4-page issue of "Bodine Motorgram," Vol. 39/No. 1, features automatic time announcers for telephone exchanges, and characteristics and application of series motors.—Bodine Electric Co., 2500 W. Bradley Pl., Chicago 18, Ill.
For more information circle **280** on inquiry card.

LABORATORY INTERVAL TIMERS are described in 2-page Bulletin TIM.—Ivan Sorvall, Inc., P. O. Box 320, Norwalk, Conn.
For more information circle **281** on inquiry card.

AIR, WATER

CHLORINE CONTROL. 8-page issue of "Topics," Vol. 12/No. 1, contains articles on chlorine control and chlorinators for water treatment.—Wallace & Tiernan, Inc., 25 Main St., Belleville 9, N. J.
For more information circle **282** on inquiry card.

AIR DRYERS. 12-page Catalog D3 describes large-volume compressed air dryers. Dewpoint and capacity graphs are available.—Van Products Co., 5807 Swanville Rd., Erie, Pa.
For more information circle **283** on inquiry card.

LABORATORY, ANALYTICAL

OXYGEN ANALYZER. Model D2, is described with specs in 2-page Bulletin 749.—Beckman/Scientific and Process Instrument Div., 2500 Fullerton Rd., Fullerton, Calif.

For more information circle **284** on inquiry card.

SPECTRO PHOTOMETER. 16-page Brochure KVH 15910 describes the Model 4000-A spectrophotometer for ultraviolet, visible and near-infrared wavelength regions.—Perkin-Elmer Corp., Instrument Div., Main Ave., Norwalk, Conn.

For more information circle **285** on inquiry card.

CONTINUOUS ANALYZER. 8-page brochure describes the AutoAnalyzer, an automated system for continuous chemical analysis, that can analyze trace materials down to parts per billion, and continuously record results. —Technicon Controls, Inc., Chauncey, N. Y.

For more information circle **286** on inquiry card.

WATER BATHS. 4-page Bulletin 5515-B describes and illustrates new high-and-low-temperature utility baths for the laboratory.—Soiltest, Inc., 4711 W. North Ave., Chicago 39, Ill.

For more information circle **287** on inquiry card.

NUCLEONICS

NEUTRON GENERATOR. 8-page brochure describes 100,000-volt positive ion accelerator for use extending from the training of university and college students in nuclear science to the development of activation analysis schemes for industrial applications.—Texas Nuclear Corp., P. O. Box 9267, Allandale Station, Austin 17, Texas.

For more information circle **288** on inquiry card.

MIXING EVALUATION. 4-page Bulletin No. 2 describes evaluation of mixing techniques with radioactive isotopes.—Nuclear-Chicago Corp., 229 West Erie St., Chicago 10, Ill.

For more information circle **289** on inquiry card.

DATA HANDLING

GEARED ENCODER SYSTEMS are subject of 4-page Bulletin 316.—Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

For more information circle **290** on inquiry card.

DIGITAL RECORDING EQUIPMENT. 6-page Bulletin SA-81 contains information on scanning printer, print-punch combinations, etc.—Clary Corp., 408 Junipero St., San Gabriel, Calif.

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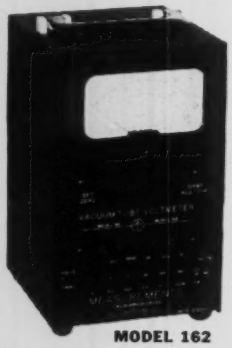

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NEW LITERATURE

DIGITAL TAPE SYSTEM ASSEMBLIES. Four 2-page Bulletins 4035, 4031, 4032, and 4033 describe and illustrate card rack/power supply assembly; output translator (flip-flop type); and pulse type; and read amplifier, respectively.—Ampex Corp., Instrumentation Div., 934 Charter St., Redwood City, Calif.

For more information circle **292** on inquiry card.

TELEMETRY DATA REDUCTION. 8-page Bulletin describes automatic data reduction systems for FM, PAM, PDM, and PCM telemetry data into magnetic-tape format.—Epsco, Incorporated, 588 Commonwealth Ave., Boston 15, Mass.

For more information circle **293** on inquiry card.

MAGNETIC TAPE READER. 2-page brochure describes Magnetic Reader, Model 58, which simplifies home and professional movie sound editing.—McMurry Audio Electronics, Inc., 9740 Washington Blvd., Culver City, Calif.

For more information circle **294** on inquiry card.

TRANSISTOR DIGITAL SUBSYSTEMS are described in new 8-page brochure.—Tempo Instrument, Incorporated, P. O. Box 338, Hicksville, N. Y.

For more information circle **295** on inquiry card.

HIGH-SPEED PRINTER. 6-page folder U189 describes the Univac high-speed printer.—Remington Rand, 315 Fourth Ave., New York 10, N. Y.

For more information circle **296** on inquiry card.

RECORDERS, MONITORS

OPERATION RECORDERS. 4-page Bulletin 1058 describes applications of operation recorders to inspect tin plate; check switch assemblies; and monitor plastic and metal molding.—Esterline-Angus Co., Inc., P. O. B. 596, Indianapolis 6, Ind.

For more information circle **297** on inquiry card.

FLASH POINT RECORDER. 4-page Bulletin No. 702 describes instrument which draws samples from process stream and continuously records the results.—Precision Scientific Development Co., Div. of Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

For more information circle **298** on inquiry card.

TEMPERATURE MONITOR. Model 310, and Indicator, Model 311, are described in new 30-page Catalog No. 3036C.—Thomas A. Edison Industries, McGraw-Edison Co., Instrument Div., West Orange, N. J.

For more information circle **299** on inquiry card.

RADIATION MONITORING. 24-page Booklet P-31 contains information on "Radiation Monitoring with Kodak Personal Monitoring Films."—Eastman Kodak Co., Products Sales Div., Rochester, N. Y.

For more information circle **300** on inquiry card.

TESTING

NETWORK ANALYZER. 4-page Bulletin GEA-6174A, CPB-4A, describes features and applications of Model 307 a-c network analyzer.—General Electric Co., Computer Dept., Phoenix, Ariz.

For more information circle **301** on inquiry card.

COMPARATORS. 4-page Circular 623 describes portable Trans-Limit Comparators.—Pratt & Whitney Co., Inc., Charter Oak Blvd., West Hartford 1, Conn.

For more information circle **302** on inquiry card.

FORCE CALIBRATOR. 2-page Bulletin D-103 describes Model 170 portable digital indicator and force calibrator, a calibration standard for weight, force, and thrust measuring systems.—Gilmore Industries, Inc., 13015 Woodland Ave., Cleveland 20, Ohio.

For more information circle **303** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

ELECTRONIC INSTRUMENTS, 64-page Bulletin P1245-A contains complete specifications of potentiometer and bridge instruments in indicating, recording, and controlling models, including new rack mounting, high-speed and multi-point, and miniature instruments as well as standard round-chart and strip-chart instruments. One section is devoted to sensing elements and attachments.—The Bristol Company, Waterbury 20, Conn.

For more information circle **304** on inquiry card.

ELECTRONIC RECEIVER. 8-page Bulletin OE-1003 lists specifications for PowrLog H-O receiver, used in temperature, pH and conductivity measurement, and a-c and d-c closed circuit telemetering; also different applications.—Hagen Chemicals & Controls, Inc., Route 60 at Campbell Run Rd., P. O. Box 1346, Pittsburgh 30, Pa.

For more information circle **305** on inquiry card.

VOLT-OHM-MILLIAMMETERS. 8-page Catalog 38-T contains illustrations and descriptions of 11 V-O-M's in different styles and ranges, also other test equipment.—Triplett Electrical Instrument Co., Bluffton, Ohio.

For more information circle **306** on inquiry card.

ELECTRONIC APPARATUS. 12-page Catalog 891-C contains information (with illustrations and charts) on pulse equipment, oscillators, signal generators, bridges, meters, frequency standards, and waveform measuring equipment, etc.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

For more information circle **307** on inquiry card.

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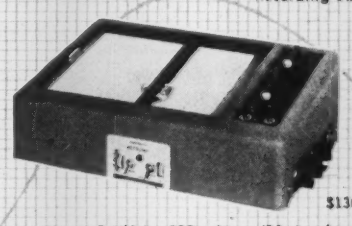

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X = 5 MV to 500 volts (11 steps) or 5, 10, 50, 100, 500 seconds

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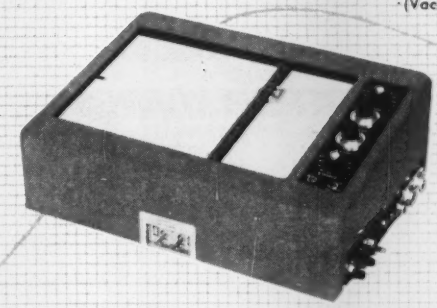

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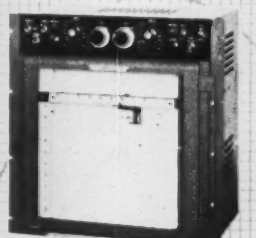

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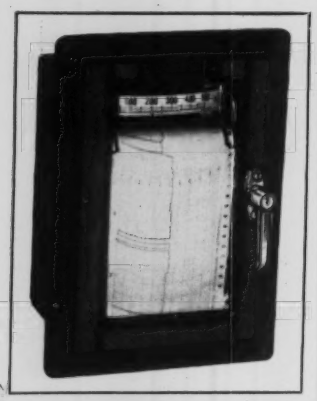

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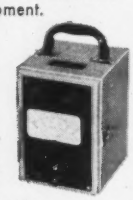

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NEW LITERATURE

VOLTAGE DIVIDER. 2-page issue of "Precision," Vol. 1/No. 2, contains information on Model VDR-106 voltage divider with one-part-per-million absolute accuracy.—Julie Research Labs., Inc., 556 W. 168 St., New York 32, N. Y.

For more information circle **308** on inquiry card.

DIGITAL VOLTMETERS. 4-page Catalog describes three lines of digital instruments for measuring a-c and d-c voltage, voltage ratio and resistance.—Non-Linear Systems, Inc., Del Mar, Calif.

For more information circle **309** on inquiry card.

MICROWAVE TESTING. 2-page Bulletin 100 describes a variety of microwave testing equipments.—Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y.

For more information circle **310** on inquiry card.

FREQUENCY DECADES. 12-page Bulletin contains descriptive information on Schomandl frequency measuring equipment imported from West Germany.—Electronic Applications, Inc., 194 Richmond Hill Ave., Stamford, Conn.

For more information circle **311** on inquiry card.

SWITCHES, RELAYS

RELAYS featuring molded-module contact springs are subject of 2-page Bulletin 160.—Ohmite Mfg. Co., 3679 Howard St., Skokie, Ill.

For more information circle **312** on inquiry card.

RELAY AND D-C MOTOR applications are treated in 4-page issue of "Electrical Component News," Vol. 4/No. 1.—Barber-Colman Co., 1300 Rock St., Rockford, Ill.

For more information circle **313** on inquiry card.

MERCURY PLUNGER RELAYS. Manual on mercury plunger relays includes load ratings, contact data, coil characteristics, mounting dimensions, diagrams, illustrations and technical articles on application engineering.—Ebert Electronics Corp., 212-32B Jamaica Ave., Queens Village 28, N. Y.

For more information circle **314** on inquiry card.

LIMIT SWITCHES for heavy duty are described and illustrated in 16-page Catalog 84.—Micro Switch, a division of Minneapolis-Honeywell Regulator Co., Freeport, Ill.

For more information circle **315** on inquiry card.

SEMICONDUCTORS

MAGNETIC AMPLIFIERS. 6-page "Techni-Topics," No. 4, discusses "What is a Magnetic Amplifier?".—Magnetic Controls Co., 6405 Cambridge St., Minneapolis 16, Minn.

For more information circle **316** on inquiry card.

SEMICONDUCTOR PREFORMS. 4-page Bulletin A-68 describes high-purity semiconductor preforms used in making alloy junctions in germanium and

silicon devices. Includes information on analyses of alloys.—Accurate Specialties, Inc., 37-11 57th St., Woodside 77, N. Y.

For more information circle **317** on inquiry card.

WIRE, TUBING

PLUG/HARNESS SYSTEMS. 8-page Catalog HC-1 contains description of Cannon Plug/Harness System facilities for missile circuitry, etc.—Cannon Electric Co., P. O. Box 3765, Terminal Annex, Los Angeles 54, Calif.

For more information circle **318** on inquiry card.

WIRE—CABLE—TUBING. 20-page Catalog T-258 and 12-page price sheet contain information on high-temperature Teflon tubing, aircraft wires and cables, subminiature wire and cable, spiral-shielded mike and audio cable, intercom cables, etc.—Birnbach Radio Co., Inc., 145 Hudson St., New York 13, N. Y.

For more information circle **319** on inquiry card.

QUICK-SEAL COUPLINGS. 20-page Catalog Q. S. R. 58 describes Quick-Seal couplings for hydraulic and pneumatic applications.—Titeflex, Inc., Hendee St., Springfield 4, Mass.

For more information circle **320** on inquiry card.

FABRICATION & MISCELLANEOUS

CAPABILITIES. 46-page Booklet, entitled "Capabilities Illustrated," treats the subject of capabilities only with exclusion of all references to products, facilities, personnel and all related factors.—Cook Electric Co., 2700 North Southport Ave., Chicago 14, Ill.

For more information circle **321** on inquiry card.

SOLDERING TIPS. 2-page Catalog Sheet 601 covers Soldering Iron Tips, including plug tips, from $\frac{1}{8}$" to $1\frac{1}{8}$" dia and screw tips from $\frac{1}{8}$" to $1\frac{3}{4}$" dia.—Hexacon Electric Co., 295 W. Clay Ave., Roselle Park, N. J.

For more information circle **322** on inquiry card.

MICROFILM READER. 4-page Bulletin describes and illustrates Filmsort Designer 184 which shows microfilms with a magnification of 15x.—The Filmsort Co., Pearl River, N. Y.

For more information circle **323** on inquiry card.

ITV CAMERAS, Models 1986C and 1986CN, are described in new 4-page illustrated Data Sheet 6-100.—KIN TEL, Cohu Electronics, Box 623, San Diego, Calif.

For more information circle **324** on inquiry card.

POLYESTER GLASS LAMINATES. 4-page Bulletin "Polyester Glass Dilecto and Celoron" describes the various grades and properties of CDF polyester glass Dilecto, and suggests applications. Also describes custom molding available with CDF celoron polyester glass.—Continental-Diamond Fibre Corp., Newark, Del.

For more information circle **325** on inquiry card.

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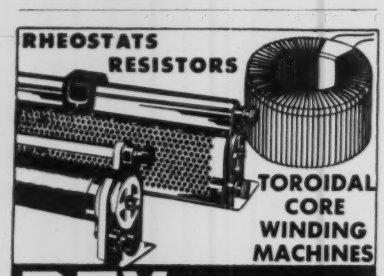

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MINIATURE TERMINAL BOARDS. 2-page Technical Bulletin contains complete specifications, outline dimensions and general information on Continental Connector Series MT terminal boards.—Electronic Sales Div., De-Jur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

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LINT-FREE UNIFORMS. 4-page folder illustrates and describes synthetic lint-free and acid-resistant uniforms for industry.—Angelica Uniform Co., 1427 Olive St., St. Louis 3, Mo.

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PROCESS MONITOR. 2-page bulletin describes and explains Graphalarm Detector Systems of monitoring process variables for normal and off-normal conditions.—Swanson Engineering and Mfg. Co., 1133 East Redondo Blvd., Inglewood, Calif.

For more information circle **329** on inquiry card.

OUTER SPACE. 16-page booklet "Introduction to Outer Space" contains the Introductory Statement, prepared in non-technical style by President Eisenhower's Science Advisory Committee. Available free from The Hays Corp., Michigan City, Ind.

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TRACING TEMPLATES. Package of 14 design tracing templates of basic mechanical components such as: gears, dials, cams, differentials, handcranks, shafts, pullies, speed reducers and couplings available "free".—PIC Design Corp., Sub. of Benrus Watch Co., Inc., 477 Atlantic Ave., East Rockaway, L. I., N. Y.

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ULTRASONIC CLEANERS. 2-page data sheet on giant size Series 5000 Son-Blaster ultrasonic cleaner for mass-production cleaning of mechanical, electronic, optical, horological, aircraft or missile parts; for cleaning of radioactive elements, "hot" lab apparatus, medical instruments, ceramic materials; electrical components and technical glassware.—Narda Ultrasonics Corp., 625 Main St., Westbury, L. I., N. Y.

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GRINDING WHEELS. 2-page issue No. 2 of "Cutting Trends" describes and illustrates 2 new methods for manufacturing ultra precision grinding wheels for metal, wood, paper and allied industries.—Simonds Worden White, 1101 Negley Pl., Dayton 7, Ohio

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FREQUENCY RESPONSE. 4-page Bulletin 81407 describes and illustrates

slide rule which provides simple determination of amplitude ratio and phase vs frequency of transfer functons.—Boonshaft and Fuchs, 994 Byberry Rd., Huntingdon Valley, Penna.

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LUBRICATING OIL PACKAGING. Brochure PED-259 describes use of high-speed Votator Filler for continuous, automatic product flow in packaging lubricating oils, antifreeze and related products.—Girdler Process Equipment Div., Chemetron Corp., Louisville 1, Ky.

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MATERIALS HANDLING PRODUCTS. Catalog MS-57 illustrates and describes custom-built baskets, racks and metal specialties for materials handling and processing.—Wire & Iron Products, Inc., 1722 Sixteenth St., Detroit 16, Mich.

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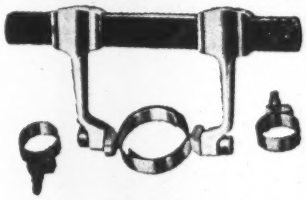

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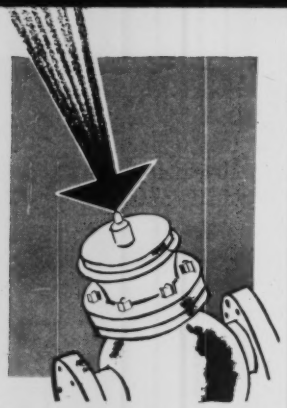

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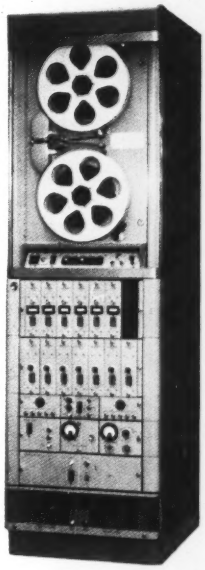

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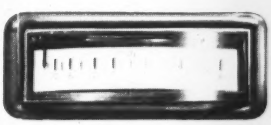

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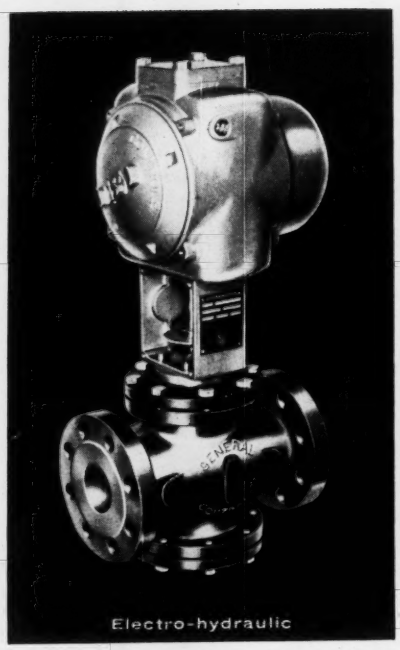

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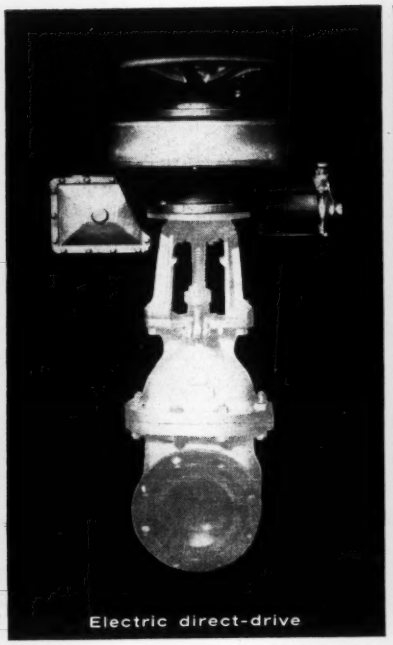
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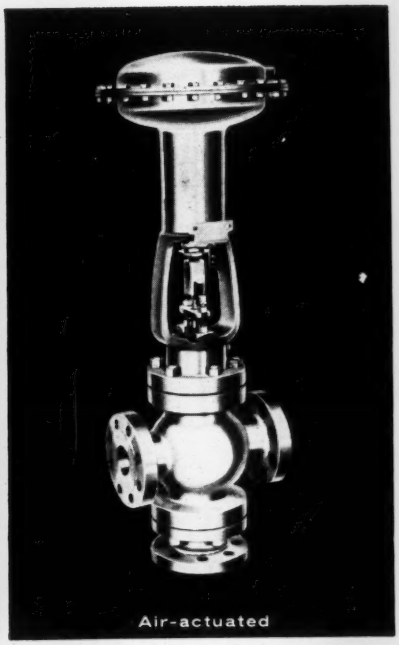
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